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9 February 1984 No 1396 Weekly 80p

newscientist

Why a hard life leads to slow sex

Two natural resources help brighten the horizon. Young minds and North Sea oil.

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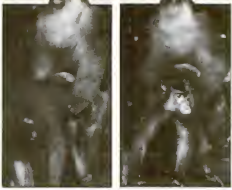

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NEXT WEEK

Old age can kill the bomb
Atomic bombs need tritium—radioactive hydrogen—to set them off. But tritium has a short half-life. So if we do not add to the present stock of nuclear weapons, they will gently fade away.

How the world came from nothing

The brain is a computer: or is it?

An engine for change

For the first time in 200 years, Britain imports more manufactured goods than it exports. Sir Kenneth Corfield argues that service industries cannot fill the gap.

ONE OF THE PRIME objectives of the Engineering Council is to encourage the efficiency and competitiveness of industry and commerce in Britain. The council has eagerly embraced this challenge. We are convinced that a strong manufacturing base is vital to creating the wealth and standard of living to which we in this country aspire. We reject the arguments of those who advocate a solely service economy. It is manifestly clear by simple arithmetic that such activities alone cannot create sufficient wealth and employment.

The Engineering Council sees itself as the "engine for change" and while we can see around us many outstanding British achievements, we are all aware of the need to arrest, and indeed, reverse, the negative trend in our share of world trade.

We know British industry can be competitive. But it depends on the determination and ability of all directors and managers in our manufacturing organisations. That is where the prime responsibility lies. These leaders of industry want encouragement and a climate in which they can progress and this is what the council's industry initiatives, covering finance and technology, are intended to achieve.

Getting ahead and staying ahead of world competitors needs new technology. This is expensive, and requires long lead times. So investors have to be prepared to take a long-term view. This they can do only if they work closely with the companies concerned and can make comprehensive appraisals of these companies' plans.

The Engineering Council is distributing a booklet on how investors should look at manufacturing enterprises. We hope it will help to build bridges between investors and directors to ensure the investment in the development of new products and processes vital to a prosperous industry.

Over the past decade or so modern management techniques and the problems of dealing with legislation have tended to squeeze technical issues out of boardrooms. It is vital that technology is brought to the forefront in a company. Products and systems really have to be at the leading edge in terms of technology and performance: craftsmanship is no longer enough. It is brain power, design, development, manufacturing and other skills that represent the needs of the future.

And we also need a determination to change and keep changing. Lathes and other equipment used typically to last 20 years or more; now we find that the speed of market changes can make equipment redundant in two years.

So, companies must invest in the right resources so that advanced research, design, development and manufacturing systems will produce products that will restore Britain's share of world markets. Technical reviews of companies help to achieve success by highlighting strengths and weaknesses so that the latter can be corrected and the former exploited. Many companies already use such techniques and we are encouraging a big expansion in their use by all manufacturing companies. Our booklet on this subject is essentially a tool by which management can devise technical review methods most suitable for their situation and most readily integrated into their stratgic plan.

We are confident that these activities will provide a framework for initiative at all levels in companies, and will help investors to provide effective and timely support. ☐

Sir Kenneth Corfield is chairman of the Engineering Council, which was set up in 1981 to advance, among other things, the professional status of engineers. He is also chairman and managing director of STC.

Lost in space

NO, don't mock. It wasn't President Reagan's fault that NASA lost a couple of expensive satellites just days after its chief had talked so glowingly of the US's future in space. These things can happen to anyone. NASA didn't gloat when the European Space Agency scattered millions of pounds worth of expensive hardware all over the ocean it got quietly on with the business of selling the shuttle as a "space delivery system".

The weekend's mishaps have some serious implications, though. There are some who will worry for those poor unfortunates at Lloyd's of London whose gamble didn't pay off. The insurance underwriters can look after themselves: you can be sure that there'll be a profitable (for someone) wrangle over who is responsible for, and foots the bill for, the random walk of the two satellites.

No, the people you have to feel sorry for are those three brave members of Her Majesty's Armed Forces who would dearly love to be become the UK's first astronaut. The urge to go into space is tremendous, even at second hand. There is no chance of an admiral or a general joining NASA's clean-cut lads, but so strong is the urge to rub shoulders with the first Briton to see quite how minute the country is from the right vantage point that the usually buried rivalry between the Army, Navy and RAF has surfaced as an unseemly knockabout in pursuit of publicity for each service's particular astronaut.

That ticket for a free ride in the shuttle seems to be the only conceivable reason why the Ministry of Defence should ask NASA rather than ESA to launch a new round of satellites for military communications. It may be that the government will, as Westar VI and Palapa B2 perform their space minuet, think again. If not, the return home of Britain's first astronaut could be most embarrassing. ☐

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Sizewell's waste destined for long-term store

Roger Milne

THE CENTRAL Electricity Generating Board (CEGB) has decided to postpone "as far as possible" the reprocessing of spent fuel from its proposed Sizewell B nuclear power station. Instead of sending the spent fuel to Sellafield for reprocessing, the board will store it at a giant air-conditioned warehouse, along with thousands more tonnes of spent fuel from its Advanced Gas-cooled Reactors.

In the last year, the board has spent £2 million on design contracts for the warehouse, which could store the fuel for 100 years or more. The board will soon be ready to submit a planning application for the complex, which could grow up to half a kilometre long.

Waste store at Wylfa: dry run for a much larger national store

The board's decision to postpone reprocessing of Sizewell waste is revealed in a memorandum sent recently to senior management. It reflects a growing concern about the cost of the "back end" of the fuel cycle.

The CEGB has still not signed a contract with British Nuclear Fuels for the reprocessing of fuels from its Advanced Gas-cooled Reactors (AGRs) at the THORP facility, which is due to come into operation in 1990.

THORP was the subject of the acrimonious Windscale public inquiry in 1977. Then the facility was described as an essential feature of nuclear power production in Britain.

The design for the CEGB's store for spent nuclear fuel is now virtually settled. The board's scientists will shortly begin test on an American-designed plasma arc welder, which will play a key role in the remote handling of the steel containers that will hold the spent fuel.

The store will take the form of a concrete blockhouse. Spent fuel will arrive by rail in flasks. It will be dried and transferred to the steel containers in up to 30 separate vaults inside the blockhouse. Heat from the fuel will be removed by a sophisticated air-circulation system.

Up to 30 vaults will be built at the store—sufficient capacity to take all the spent fuel from the existing programme of AGR stations. The design has been modified to allow it to handle spent fuel from pressurised-water reactors, such as the proposed Sizewell B reactor.

Design work has been intense in the last year. The National Nuclear Corporation (NNC) has developed the design of the vaults and the container-handling equipment, which is based on machinery used for the loading of fuel into AGR stations. The design of the reception area for flasks has been undertaken by GEC Energy Systems. GEC is a senior partner in the NNC and has already developed a similar, though much smaller, store for spent fuel at the CEGB's Wylfa power station in North Wales. The vault ventilation system has been developed by Taylor Woodrow, and the active waste treatment plant by Matthew Hall.

The need for the store hinges on technical, political and commercial considerations, underlying the growing indecision about handling spent fuel. At the heart of the case is the CEGB's conviction that it is being offered worse terms for the reprocessing facilities at THORP than overseas customers. The board has so far refused to sign a contract for THORP. When it has its own store at which it can store spent fuel more or less indefinitely, its bargaining position will be incomparably stronger.

The board has not ruled out the possibility of sending its fuel abroad for reprocessing. ☐

OBSERVER David Austin
THIS WAY WE GET TO SPACE-WALK ON THE STAR-WARS BUDGET!

Leaks swamp Sizewell inquiry

PETER Walker, the Secretary of State for Energy, has assured the Sizewell B inquiry about his decision to let the Central Electricity Generating Board (CEGB) place orders for hardware for the proposed pressurised-water reactor before the inquiry has ended. He says that it will not prejudice his decision on the outcome of the hearing, which is likely to run until the autumn.

Whitehall has accepted the board's view that to avoid a possible 2-year delay in constuction as well as extra costs, forgings for the pressure vessel and other castings for parts of the primary circuit must be ordered now. John Baker, a member of the CEGB, said that commercial necessity had outweighed the risk of adverse publicity.

The CEGB has indicated that, although forgings for the pressure vessel are being ordered now, the stainless steel "heart" of the reactor will not be fabricated unless and until the government approves the scheme. This may go some way to mollify Suffolk County Council whose chief objection to the safety of the project hinges on the design of the pressure vessel.

The CEGB faces an important challenge this week over its claims for the safety of the PWR. Friends of the Earth is cross-examining the board on a report prepared by experts from the board and the United Kingdom Atomic Energy Authority. The leaked document questions the reliability of predictions made for the effectiveness of the PWR's cooling system during an accident.

The document was prepared for the government's own safety watchdog, the Advisory Committee on Safety of Nuclear Installations (ACSNI). It describes experiments held in 1981 at the EEC's joint research centre at ISPRA in Italy. British experts were among 16 safety teams which took part in the simulation of accidents involving the loss of coolants.

The report indicates that computer programs used to predict what might happen were sometimes wrong and that some accident sequences were so complex that operators could not make the correct decisions to control the accident. ☐

Soviet physicist could face new jail term

A NEW attempt to win freedom for Uri Orlov, the physicist from the Soviet Union who was jailed for his support of human rights, was launched in London yesterday by his British lawyer, John Macdonald, QC.

Orlov, who once worked on high-energy particle accelerators, was one of the founders of the Soviet Helsinki Watch Group in 1976. At his trial in 1978 he was convicted of anti-Soviet agitation and sentenced to seven years' imprisonment in a strict-regime labour camp. The sentence was to be followed by five years' exile.

Orlov's camp term is due to end tomorrow, 10 February. But his wife, Irina, fears that he may be jailed for a further term. Last year Soviet law was changed so that people who had completed their sentences could be locked up for a second term on the recommendation of the camp commandant. Since then a number of dissidents have had their prison-camp terms extended (*New Scientist*, 5 May 1983, p 321).

Macdonald wants the Soviet Union's Procurator-General to carry out a review of Orlov's trial, on the grounds that the court did not examine all the evidence available to it. First, there were three people present who were prepared to appear as witnesses for the defence, but who were never called. Secondly, Macdonald had prepared a dossier on the case which again, though available, was not examined. The Soviet code of criminal procedure makes provisions for such trial reviews. They have to be initiated by the Procurator-General or Supreme Court.

Orlov: more years inside?

An important part of Macdonald's initiative is his request that Orlov be freed pending the outcome of the review and allowed to live in Moscow. Orlov's health has deteriorated during his seven years' imprisonment. He embarked on several hunger strikes and was often put in the punishment cell where hot food is served only every other day.

The imprisonment of Orlov has damaged scientific relations between the Soviet Union and the West since 1978. That year, 2400 American scientists formed Scientists for Orlov and Shcharansky (SOS). They signed pledges that they would cut back sharply their participation in US-Soviet scientific relations.

A Uri Orlov Committee, set up among scientists at CERN, Europe's centre for particle physics, campaigned for his early release. It put pressure on the CERN council to take an initiative, because of the extensive cooperation between CERN and the Soviet Union. And the committee prevented the International Conference on High-Energy Physics from being held in Moscow this year. □

Cooperation urged for satellite sensing

INTERNATIONAL competition in satellite sensing will be fierce, but at the same time development of this technology cannot be confined to national boundaries. These are two points made in a report published yesterday by a House of Lords' select committee on remote sensing and digital mapping.

The committee concludes that the technology of remote sensing from space could bring large rewards to British scientists and industry. It recommends a national computer network to distribute satellite pictures of Earth and calls for Britain to concentrate on developing radar in space.

Remote sensing relies on instruments in satellites or aircraft picking up radiation from the land and sea and forming an image of the Earth that can be useful in mineral exploration, oceanography, fisheries and crop forecasting.

If British users of remote sensing are to benefit in full they will need access to better processing facilities to develop all the possible applications, says the committee.

The development of digital mapping was the second part of the committee's brief. In this technique geographical data are converted to a digital signal so that it can be stored in a computer.

The committee recommend that the 220 000 large-scale ordnance survey maps should be digitised by 1994, and 204 small-scale Landranger maps by 1987. An advantage is the ability to note changes occurring in a landscape from year to year.

Lost satellites and exploding balloon mar shuttle flight

NASA is suffering from acute embarrassment this week after the failure of two satellites and a balloon that were launched from the latest shuttle flight. McDonnell Douglas, the firm that build the rockets that failed, faces something worse—a huge setback for its billion-dollar rocket business.

Ironically, the shuttle, which is far more complicated than most of its cargoes, performed flawlessly during the first four days in orbit. But three payloads—two communications satellites and a balloon that was to be used as a target for manoeuvring and docking in space—inexplicably went awry, ruining more than half the projects planned for the eight-day mission, the tenth shuttle flight.

Shuttle heads into orbit—and mishaps galore

Steve Helber/AP

Eight hours into their flight, the crew of Challenger (making its fourth trip into space) opened the shuttle's bay doors and gently pushed Westar VI, a communications satellite, into space. After the Challenger withdrew to a safe distance, the satellite's onboard engine, which was to propel it into stationary orbit well above the shuttle's position, apparently misfired. NASA says the shuttle and crew were not at fault.

The crew did not see what happened and scientists on the ground are still perplexed. For several hours, no one could find the satellite, which was powerless and silent. When it was finally spotted, the satellite was in too low an orbit to be of use to its owner, Western Union. The second satellite failure came on Monday when a $200 million satellite belonging to the Indonesian government failed. The rocket engines reponsible for the loss of the satellites, are made by McDonnell Douglas with components from the Hughes Corporation. In each case it appears that PAM, the upper stage of the booster rocket, failed. They had previously boosted several satellites into upper orbits without a hitch.

Things went from bad to worse on Sunday. The crew put into space a cannister containing a folded balloon that was to inflate and drift near the shuttle for several days. Commander Vance Brand and the pilot, Robert Bigson, were to practise manoeuvring close to the balloon, in preparation for a rendezvous with a satellite in April. Then a shuttle crew will attempt to rendezvous with the damaged Solar Maximum Mission Satellite and make running repairs to the craft.

But the cannister did not pop open as planned. Then, when it did, the balloon over-inflated and blew up. NASA officials do not yet know why. □

Search for missing uranium

Lee Torrey, Philadelphia

AMERICA'S largest nuclear weapons plant, in Oak Ridge, Tennessee, has lost more then 770 kilograms of highly enriched, weapons-grade uranium, the government learned last week. An investigation has been launched to discover whether the loss was covered up by plant employees.

The revelation follows the withdrawal of the Union Carbide Corporation from management of the Oak Ridge complex. The contract is being taken over by the Martin Marietta Corporation.

On Monday this week, Congress's House Armed Services Committee summoned the plant's managers to explain the likely causes of the lost uranium and why 27 computerised inventory-tapes had been erased or damaged. Experts in Washington DC say that the losses at Oak Ridge bring the total of unaccounted enriched uranium that has not been accounted for in the US since 1950 to more than 4500 kg—enough to make about 225 bombs the size of the one that demolished Hiroshima.

The supervisors at Oak Ridge of what is known as Plant Y-12, which has assisted in the manufacture of virtually all of America's 26 000 nuclear warheads, assured Congressmen gathered in secret session that "there was no evidence of theft or diversion" of the missing uranium from the plant.

They believe that the uranium-235 has been lost inside pipes, filters and other parts of the plant during the machining, rolling and casting of weapons. Other discrepancies in the inventory could have arisen from faulty paperwork.

Whatever the cause of the discrepancies, the Inspector-General of the Department of Energy is investigating the damage to the inventory tapes. Apparently the plant managers learned of the damage last June, but failed to report it to the government. This is a violation of federal regulations.

Joe La Grone, a manager at Oak Ridge, acknowledged that this incident may represent a failure of the government's system to monitor and control weapons-grade materials. More than 600 tonnes of enriched uranium have passed through Plant Y-12 since 1950. The disappearance of 770 kg represents a rate of loss of little more than one in a thousand. So many experts are unperturbed by the apparent disappearance of so much uranium.

The possibility of theft or diversion of enriched uranium cannot be ruled out. One congressional investigator says that the CIA had left lawmakers with the "strong impression" that more than 100 kg of enriched uranium missing from a plant in Apollo, Pennsylvania, was diverted to Israel in 1967. A subsequent investigation of this incident was inconclusive.

"There is no doubt in my mind that the government has a serious problem tracking weapons-grade materials," says Dr Paul Leventhal, director of the Nuclear Control Institute in Washington DC.

"Even in the best run plant there are going to be discrepancies of the order of 0·5 per cent. Actual figures from the Nuclear Regulatory Commission show that some plants have losses between 1 per cent and 4 per cent. I hope the discrepancy at Oak Ridge is an innocent loss, but I also believe that a skilled diverter could work within the system. And this is why the breakdowns of government regulation in this area can be very dangerous", said Leventhal. □

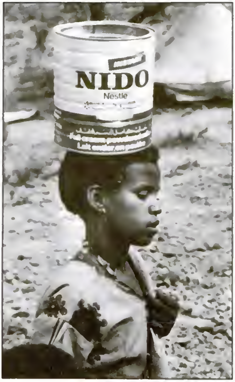
Baby milk firm backs down

CONSUMERS' groups are claiming their first ever victory over a multinational food firm. Activists from more than 20 countries agreed in Mexico City last week to suspend their six-year boycott of Nestlé after the company promised to stop its aggressive promotion of "infant formula" baby milk in the Third World.

Activists had won the support of the World Health Organisation (WHO) for their claim that its promotion of infant formula discouraged breast feeding and contributed to malnutrition among children in countries where the product often cannot be prepared safely.

Now Nestlé has agreed to accept the WHO's marketing code in the Third World. It will not routinely distribute free samples to hospitals and will not advertise in the mass media. The boycott's organisers hope that Nestlé will persuade other firms to follow suit.

Meanwhile a British code, written by the baby-food firms themselves, but adopted by the Department of Health and Social Security, remains in effect—despite opposition from the National Childbirth Trust and the British Medical Association (*New Scientist*, 11 August 1983, p 392). Opponents of the code argue that it legitimises most of the practices that the WHO has been trying to discourage. □



UNICEF/Iain Guest

No need for Nido

Test conference is off

PLANS for an international conference on the effects of testing nuclear weapons have been frozen following a "shift of priorities" by the organisers. Last July, a French committee of environmental experts commissioned by, but critical of, the French defence ministry put forward the idea of a conference. The committee argued that it would open up the debate.

The head of the committee, Haroun Tazieff, said at the time that the authorities had agreed on such a meeting. But, last week, Tazieff said plans for the conference were shelved.

Foreign scientists—two from New Zealand, two from Australia and one from Papua—visited France's Mururoa test site at the end of last October. Because of this Tazieff now believes there is less need for a conference. The scientists are due to publish a report on their findings in the next few months. □

Noise to walk by

SCIENTISTS working for the British government are preparing a report that will point to huge gaps in knowledge about how personal stereos may damage hearing. The report, which the Institute of Hearing Research in Nottingham is drawing up for the Health and Safety Executive, is a review of literature about "leisure noise". It covers the effects of discos, shooting and even noise from football matches as well as personal stereos.

The report will go the Health and Safety Executive on 14 April. Any rules about personal stereos would have to come from the consumer protection branch of the Department of Trade and Industry.

The institute's report will point out that there is no known standard for measuring the amount of sound they produce. □

Prize computer

THE FREDKIN foundation of Boston last week issued a challenge to computer scientists and mathematicians. It will award $100 000 to the first person who can program a computer to make a major mathematical discovery.

A 12-member committee of university scientists will set the rules of the competition. The head of the committee, Woodrow W. Bledsoe, from the University of Texas at Austin, says: "The prize will be awarded only for a mathematical work of distinction in which some of the pivotal ideas have been found automatically by a computer program in which they are not initially implicit." □

Country codes

THE ROW over who should pay for preserving the Norfolk Broads, the largest remaining wetland in England (*New Scientist*, 26 January, p 5). The Countryside commission and the Broads Authority have both rejected an offer from ministers to pay 75 per cent of the cost of compensating farmers who agree not to drain pastures to turn them into cornfields. They want the government to pay 90 per cent. □

No more smoke-filled rooms

WHAT have Devon and the Greater London Council got in common? Why do councillors in Tory Berkshire see as clearly as those in Republic of South Yorkshire? The answer is that the county councils all ban smoking during meetings of the full council.

According to a survey by Action on Smoking and Health seven out of 10 councils now ban smoking during full council meetings. Many also ban smoking during committee meetings and reserve no-smoking areas in council-owned premises. Buckinghamshire does allow its councillors to smoke if the meetings stretch into the afternoon.

The move to ban smoking cuts straight across party lines. Eleven counties in England and Wales, out of a total of 53, allow smoking. Four are Conservative, four Labour, two independent and one is hung. □

Clues to four murders analysed by computer

Steve Connor

A COMPUTER program is helping to probe four murders in three different British police forces. The program was developed with West Yorkshire police after criticism over their handling of the Yorkshire Ripper case.

For several months the program has run side by side with conventional methods of indexing the mass of information that comes into a force following a "major incident", such as murder. Last week, West Yorkshire police pressed charges against three men for the murder of Noel Murgatroyd, a newsagent who lived near Leeds.

The investigation used the program. Now officers will try to discover whether the investigation could have been conducted using the computer program alone.

The program is called MICA—Major Incidents Computer Application—and has been developed by a software company, Issis Computer Services, and a computer manufacturer, Microdata, with the help of West Yorkshire police. Although most police forces have their own computers for storing criminal records and information, these can rarely handle major incidents because of the sheer volume of information that flows into an incident room.

Syndication International

Detectives shuffle paper in the incident room that handled the hunt for the Yorkshire Ripper

Leicestershire police have set up two incident rooms running side by side, one aided by the computer, to solve the murders of two women, Caroline Osborne and Linda Mann. And Nottinghamshire police are trying out MICA on the murder of 16-year-old Colette Aram.

The MICA program is menu-driven—that is, it offers the operator a number of choices of where to go in its data bank. All the people involved in the incident are entered in the Nominal Index. When entering the details, the computer searches to see whether this person, or anyone who sounds like them, have already been entered. One crucial failing of the Yorkshire Ripper inquiry was alleged to have been that reports from several interviews with Peter Sutcliffe, the culprit, were never collated.

A more comprehensive Descriptive Index holds more detailed descriptions of people who are entered in the Nominal Index.

Details of any vehicles that could be involved in the incident are entered onto the Vehicles Index, and similarly "things", such as garages, "activities" or items found near the incident, can be entered into the Category Index. Detailed statements of witnesses or suspects can be entered directly into the computer under the Nominal Document Index.

The great advantage of MICA is that it can cross-reference all these indexes simultaneously. Police officers can interrogate the computer to see whether, for example, a red Cortina has ever been associated with a woman wearing a brown coat. In the Nominal Document Index, different statements many thousands of words long can be studied by entering key words. The program will then highlight those sentences where these words appear. With card indexes, this process of cross referencing is very time consuming.

MICA also compares two or more major incidents. It can, for example, compare the sequence of events in one with another. So everything that happened on Thursday morning in two seemingly separate incidents can be listed in the order that they occurred. This could give officers working on the two cases a better idea of the events leading up to or following an incident. As one officer said "the hope is to generate new lines of enquiries".

Microdata and Issis claim that MICA is two years ahead of other such programs. The Home Office, they say, has yet to show that its major incident program, called MIRIAM, can work on real cases, and the watered-down version, called AUTO-INDEX, is but a "shadow" of what MICA is able to do. ☐

How defence chiefs tested effects of nuclear blasts

BRITAIN'S Ministry of Defence (MoD) conducted experiments in the 1950s to study the effects of atomic explosions on service personnel. The experiments came to light last month when an official document was released to the Public Record Office under the 30-year rule.

However, the MoD last week emphasised that "no men were exposed to harmful doses of radiation or other damaging effects". And it has not passed the results of the experiments on to the government's radiation watchdog, the National Radiological Protection Board, which is carrying out a survey of ex-servicemen to study whether they have suffered any effects from the nuclear weapons tests.

The document, a communication from the Chiefs of Staff Committee, states: "The Army must discover the detailed effects of various types of explosion on equipment, stores and men with and without various types of protection."

The MoD explained last week that dummies and measuring instruments were exposed to the effects of the A-bomb—but not real people. These dummies were covered with various forms of protection to study how the effects differed "with and without various forms of protection".

The document was written in May 1953, six months after Britain's first nuclear explosion off the coast of Monte Bello Islands, Western Australia. In October 1953, Britain tested two more devices at Emu Field, South Australia. It is among the first official records to be released on the A-bomb tests. It says: "Many of these tests are of the highest importance to departments, since on their results depend the design of equipment, changes in organisation and administration, and offensive and defensive tactics.

"The navy requires information on effects of various types of atomic explosions on ships, their contents and equipment". The RAF wanted information on effects to airfields, submarine bases and the oil industry, it says.

After the Monte Bello test in October 1952, an Australian naval vessel, the Hawkesbury, was sent out to survey the area and "to guard against the collection of intelligence", according to a telegram from the Commonwealth Relations Office to the British high commissioner in Australia.

An earlier signal from the Hawkesbury stated that radiation from Britain's first A-bomb explosion would pose a "considerable hazard to health" for six months and "possibly even longer". With this in mind, the Commonwealth Relations Office told the high commissioner: "We should be glad to know whether they [the Australian government] propose to take the view that any intruder is there at his own risk and to rely on their declaration of the islands as a prohibited area unsupported by any physical guard."

The high commissioner replied two weeks later saying that the Australian government would display warning notices in post offices and jetties in the area and a large notice "will be erected on the islands to the effect that persons landing there do so at their own risk".

The Australian government, however, had not by this time finalised its plans to deal with the problem of contamination, and was waiting for the latest report from the Hawkesbury. ☐

Toxic fumigant banned for US grain harvest

Christopher Joyce, Washington DC

THE US government last week banned ethylene dibromide (EDB), a popular fumigant sprayed on grain and some fruit and vegetables. And it urged shopkeepers to remove products containing the pesticide from their shelves.

The government's watchdog, the Environmental Protection Agency (EPA), voiced its concern last year about the application of EDB to kill pests in stored grain and milling machinery. But it has decided to act now after health officials discovered dangerous levels of the chemical in food.

No one knows where or how much contaminated grain is on sale or stored in silos. The government's agricultural officials estimated in 1980 that up to five per cent of American grain in storage was sprayed with EDB. But contaminated grain is often mixed with uncontaminated supplies. Last year the US produced 393 million tonnes of grain—almost one-third was exported.

EDB is a halogenated hydrocarbon similar to DDT. In 1975, scientists found that it caused cancer in laboratory animals and, later, that it caused chromosomal mutations. The EPA estimates that a population exposed to 31 parts per billion during a lifetime could expect 3·3 additional cancers per 1000 people.

When EDB was approved in 1948, grain looked clean because it was not possible to measure such small concentrations. A quirk in US law forbids the EPA from now setting mandatory maximum levels of the chemical in grain and food products.

Last week, however, the EPA gave state governments a set of optional guidelines. Levels of EDB should not exceed 900 parts per billion in raw grains that are intended for human consumption. For intermediate products that will be cooked, such as flour, baking mixes and certain cereals, the maximum is 150 parts per billion. For ready-to-eat products, such as cold cereals, snack foods, bread and baked goods, the residue should not exceed 30 parts per billion.

After the dangers of EDB's were discovered in the mid-1970s, President Jimmy Carter's advisers began pushing for a ban. Under President Reagan's EPA, however, little was done while all federal regulations were reviewed.

But in 1982, state authorities began finding the chemical in ground water—its most common use in the United States has been for killing nematodes (root worms) in soil before planting. So last September the EPA banned EDB as a soil fumigant, which accounted for about 95 per cent of the 9 million kilograms used in agriculture every year.

The EPA's director, William Ruckelshaus, has decided to wait for more information before banning the spraying of EDB on imported fruit, where it kills incipient fruit flies. He estimates that only a tiny fraction of fruit on sale in the US has been contaminated significantly.

By far the largest use for EDB in the US and elsewhere is as an additive to leaded petrol, where it prevents lead from fouling the engine. The EPA says however, that the chemical is burned up during combustion, and poses no threat to health.

Nine manufacturers of EDB challenged the EPA's initial action against the pesticide last year. But last week's emergency ban shows that Ruckelshaus is playing tough. He says he plans to clear EDB completely out of man's food chain in three years.

In Britain the use of the ethylene dibromide pesticide is restricted to fumigating machinery that handles grain. It has not been sprayed onto grain directly since 1981, (*New Scientist*, 13 October 1983, p 77). ☐

Army blackballed at JPL

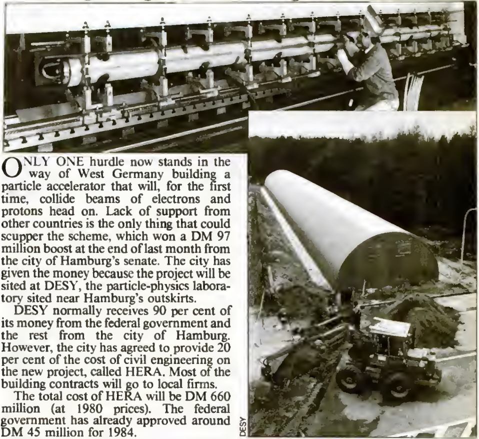
SCIENTISTS at the California Institute of Technology (Caltech) in Pasadena are objecting to the creation of a new army think-tank at the institute's Jet Propulsion Laboratory (JPL)—but there seems to be little they can do about it. About 200 faculty members last week accused the Caltech administration of misleading them over the nature of the army facility, called the Arroyo Center. Caltech administers JPL for NASA.

They say the think-tank represents a move for JPL away from high technology and systems engineering to policy matters and classified research. But the administration says JPL needs to diversify its work and funding because NASA's commitment to unmanned space exploration has been waning.

The faculty last week voted overwhelmingly for Caltech to divest itself of the army centre "expeditiously and in a responsible fashion at the earliest possible time". But the faculty acknowledged that this could not be done until the "present commitments" with the army had been carried out.

The faculty vote is advisory only. ☐

Hamburg charges ahead with particle accelerator



DESY

DESY

Test shed for the prototype magnets and (top) building the bending magnets

ONLY ONE hurdle now stands in the way of West Germany building a particle accelerator that will, for the first time, collide beams of electrons and protons head on. Lack of support from other countries is the only thing that could scupper the scheme, which won a DM 97 million boost at the end of last month from the city of Hamburg's senate. The city has given the money because the project will be sited at DESY, the particle-physics laboratory sited near Hamburg's outskirts.

DESY normally receives 90 per cent of its money from the federal government and the rest from the city of Hamburg. However, the city has agreed to provide 20 per cent of the cost of civil engineering on the new project, called HERA. Most of the building contracts will go to local firms.

The total cost of HERA will be DM 660 million (at 1980 prices). The federal government has already approved around DM 45 million for 1984.

Meanwhile, discussions continue on the possibility of support from France, Italy, Canada, the Netherlands, Israel and Britain. DESY is keen to involve scientists from Britain's Rutherford Appleton Laboratory who are experts in accelerating protons. DESY has plenty of experience in building electron machines, but none at all with protons.

If the final details of the international contribution can be settled, construction of the new machine will begin in May. Already DESY has carried out much research on the superconducting magnets needed to steer the beams through a tunnel 6·3 kilometres in circumference. The first prototype magnets are ready for testing in a specially built area that simulates conditions in the real machine.

HERA could be ready by January 1990.

It will complement the huge electron-positron collider being built at CERN, the international laboratory at Geneva, and the superconducting proton machine at Fermilab in the US.

Christine Sutton

Washington defers action on acid rain

THE HEAD of the US's Environmental Protection Agency (EPA), a government watchdog, last week defended a decision by President Reagan not to take action on acid rain. Reagan announced a doubling of funds for more research, but no controls.

When he appointed William Ruckelshaus as head of the EPA, Reagan identified acid rain as one of four priorities for the agency. Many people had expected Ruckelshaus to announce at the end of last year a programme to cut emissions of sulphur dioxide and other pollutants that cause acid rain. Instead, Ruckelshaus last week told a Senate environmental committee that no measures would be taken for the moment to control acid rain.

The Senate committee, which last year approved a bill calling for an eight-million tonne reduction in sulphur emissions, was not pleased. "I regret that all that has been accomplished since you last appeared before this committee is nine more months of delay," George Mitchell, a Democrat from Maine, told Ruckelshaus.

Ruckelshaus described Reagan's plan as "rational, not irresponsible". The door was not closed on enforcing reductions in emissions, but "before launching the country on an expensive and potentially divisive control programme, we feel we need more scientific information", especially on the scope and pace of the damage, he said.

As part of the research effort, concentrations of nitrates and sulphates in up to 3000 lakes will be monitored to determine long-term chemical and biological changes in the water.

Those data should be available by the end of this year, Ruckelshaus said. Next year a survey of the scale of damage to forests will begin. Ruckelshaus admitted that such research should have started as much as 10 years ago.

Ruckelshaus promised that if the damage is found to be worsening, then the administration would act quickly. On the other hand, if the situation is stable, then there is more time for research and planning, he said. Ruckelshaus will ask the National Academy of Sciences to set up a committee to investigate.

The senate committee was not convinced by Ruckelshaus's reassurances. It plans to introduce another control bill. But without support from the administration it has little chance of success in Congress.

Leslie Roberts, Washington DC

Industry pays for California's acid research

CALIFORNIA has discovered, to its surprise, that it has an acid rain problem. Now, with characteristic thoroughness and scientific ingenuity, the state has launched an $18-million study of the problem. Half the money to finance the work will come from the state's 35 largest industrial polluters.

The state wants a network of 36 monitoring sites. Most will be near Los Angeles and San Francisco and in the Sierra Mountain chain along the Californian border with Nevada.

Officials say the seven federal monitoring stations in the state do not provide sufficient reliable information.

California's acid rain appears to be largely home-grown. The state is not down wind of anybody else's pollution. Recent research has produced dramatic evidence of the scale of the problem. At Corona del Mar, a coastal town south of Los Angeles, droplets in a winter fog apparently had a level of 1·69 *p*H—about the acidity of Domestos. Early results from the new monitors have shown mean *p*H values below 5 in six places in southern California. Readings in Pasadena were as low as 3·1.

But the Air Resources Board, which is charged with running the new study, says that before controls are proposed, it wants to know more about how acid pollution is formed in California, and what impact it has.

The total of $18 million for the study will be spent over the next five years—$2 million this year and $4 million in each succeeding year. Half the money will come from fees levied on 35 companies—mainly from the petroleum and power industries. A portion of the fees for motor registration will pay for the rest of the research.

Scientists are concerned that acid rain will threaten streams and lakes in the Sierra Nevada, where the rocks cannot neutralise the acid. The University of California and the US Forest Service have begun testing snowmelt there for signs of acid deposition.

But a more immediate problem is dry deposition—particulates and gases that are converted into acids by water after landing on plants or buildings—and acid fogs. Southern California, which includes Los Angeles and the vast agricultural areas of the San Joaquin Valley, is most vulnerable. Production of some crops has fallen by as much as 20 per cent and pollution, including acid deposition and ozone, is being blamed.

Robert Paz, Caltech

How to sample acid fog, the Californian way

Researchers from the California Institute of Technology have concluded that dry deposition of acid is 15 times more prevalent than acid rain in the south of the state. The new study will measure both wet and dry deposition.

Michael R. Hoffman, an environmental engineer, has found that fog in the Los Angeles area is often 100 times more acidic than the rain. To capture the elusive fog droplets, Hoffman has developed a propeller-like blade that spins at 1700 revolutions per minute, pushing the moisture into collection bottles at either end by centrifugal force.

Hoffman believes that, in the evening, fog forms on the haze aerosol that made up part of the day's smog. Next morning the fog evaporates, leaving the aerosol, which helps form another smog episode.

Hoffman has developed his theories to predict the likely acidity of the notorious London smog of 1952, which killed more than 4000 people. On the basis of recorded emissions of sulphur dioxide and the height of the inversion layer, Hoffman estimates the smog would have had a *p*H of between 1·4 and 1·9. He believes that the acidity of the smog, which was not recorded, may have been an important cause of the deaths. The impact of acid fog on lungs will be part of the Californian study.

Meanwhile, researchers from the University of California at Riverside have more bad tidings for acid-deposition watchers. Using a German-designed UV spectrometer that is capable of sending light beams across 17 kilometres, James N. Pitts and Arthur M. Winer have detected the formation of nitric acid at night in Los Angeles. Previously it had been thought that nitric acid formed only during the daytime, by chemical reactions driven by sunlight. Nitrate radicals, which lead to the formation of nitric acid, have been found at night in four locations in the Mojave Desert, east of Los Angeles.

California's love affair with the automobile adds significantly to the nitrogen part of the acid equation. From March, the exhaust emission from vehicles in 19 of the counties with the worst air pollution will be checked every two years. About half of all cars are expected to fail the inspection and will require maintenance. This action is being undertaken so that the state can follow the Clean Air Act in 1987. □

Reagan reaches for the sky

Christopher Joyce, Washington DC

RONALD REAGAN'S drive to develop a new generation of weapons will take 60 cents out of every dollar in next year's federal R&D budget in the US. Reagan's budget, published last week, includes $34 billion towards Trident II, the new submarine-launched missile; MX, the inter-continental ballistic missile now renamed the "peacemaker"; the new X-1 bomber; and a host of tactical weapons for the battlefield. Not only does defence win a bigger slice of the R&D cake—the cake has also grown, by 14 per cent to $53 billion. One of the biggest new ventures is the "strategic defence initiative", commonly known as star wars. This venture includes plans to build laser machines and particle-beam accelerators both on Earth and in space to shoot down the Soviet Union's nuclear missiles in flight. It also supports research into anti-satellite weapons. The star wars bill will run to $1·7 billion next year. That is, about seven times what the government spends on research in the environment and twice the total agricultural research budget.

Once military spending is accounted for, the increase in the new R&D budget is well below the predicted rate of inflation of 4·7 per cent. The White House has made room for several new projects, however, as it continues to slice away at applied research, while fattening up basic research.

One piece of applied research that did get the nod is the first small step, costing $150 million, toward building an orbiting space station. Though scientists are worried that the station will devour NASA's budget for the next decade, the agency has come through with three new space science projects; a mission to orbit Mars, a satellite to probe the chemistry of the upper atmosphere, and an orbiting instrument to measure global wind patterns on the surface of the ocean.

At the National Science Foundation (NSF), which funds basic research at universities, the White House has been generous. Some of the NSF's 14 per cent boost will go to a new centre for cross-disciplinary research in engineering. NSF will also start payments on a new project for astronomers, the Very Long Baseline Array (VLBA). It will consist of several radio antennas strung across the continent but acting as one instrument. It will improve the resolution of analysis of cosmic radio sources by between 100 and 1000 times.

Aside from its work on nuclear weapons, the Department of Energy continues to decline. The death of the Clinch River Breeder reactor project now seems final. Its demise will save the taxpayer many millions of dollars this year, while the search begins for a new vehicle for breeder technology. Inertial confinement fusion, which uses lasers fired at small targets to generate nuclear fusion, met its end this year as well. That leaves the field to magnetic tokamak and mirrors.

High-energy physics survived unscathed, and saw new money for planning the huge electron-accelerator to be built in Virginia. The Federal Laboratory at Brookhaven will also get a new heavy-ion accelerator.

Reagan showed his usual beneficence for the physical and mathematical sciences. But the White House's science adviser, Dr George Keyworth, also points to initiatives in biotechnology, especially for agriculture, and he calls for more young scientists to be trained in this field.

Keyworth says the government has accepted that sulphur emissions from power plants cause acid rain. The Environmental Protection Agency and the Energy Department will now spend several years on the ticklish question of whose pollution is destroying whose lakes and forests, and how to stop it (see facing page). The 12 per cent overall increase in the EPA's budget is a small victory for the revived agency and its new director, William Ruckelshaus.

Reagan's budget must first be approved by Congress. If the past three years are any guide, Congress will trim military fat and restore some of the funding for general science. ☐

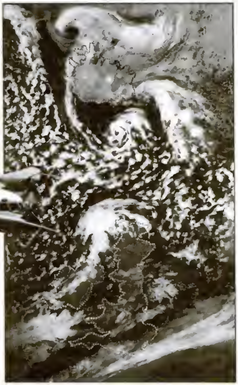
Britain's worst winters start here

THE BREEDING grounds for much of Britain's worst weather, on the edge of the Arctic Circle, are being investigated this month by reseachers from the US, Britain and Norway. The study hopes to witness the birth of the low-pressure systems, the Arctic cousins of tropical hurricanes, which sweep down from the Arctic upending ships, disrupting work on North Sea oil rigs and blanketing Britain in snow.

U.S. Dept. Commerce

The investigation started late last month, when two American research aircraft arrived in Keflavik, Iceland, carrying a wealth of scientific instruments. For two weeks scientists from the National Oceanic and Atmospheric Administration (NOAA), NASA and the US Navy studied the interaction between atmosphere and ocean, and between warm water and ice off the east coast of Greenland, where ice flows 3000-metres thick enter the sea. It is here that the Icelandic lows appear to be born.

This week, the American scientists are moving to Bodo in Norway, where scientists from the British and Norwegian meteorological services are to join them. Here the team will begin the first detailed study of a second breed of Arctic low-pressure systems—the small, violent storms known as polar lows. They resemble tropical hurricanes and appear to be whipped up in areas where open, relatively warm water is swept by strong outbreaks of cold polar air from the icecaps.


Polar lows form around Iceland and head south. Left: Tracker planes follow

Melvyn Shapiro, a meteorologist at NOAA, says these Arctic hurricanes are perhaps 150-kilometres wide with maximum wind speeds of 80 knots. Some even have an "eye" in the centre. "We can't say now whether they are produced by convection or by heat transfer from the ocean or by a passing wave in the mid-troposphere. We don't know if they are warm-core like hurricanes or cold-core, as mid-latitude cyclones are supposed to be."

As oil rigs march steadily northwards in the North Sea the importance of understanding these Arctic hurricanes grows.

The techniques for probing Arctic storms are the same as those developed for exploring tropical hurricanes. An initial sortie is made by an aircraft into a stream of cold air where, if the predictions are correct, a polar low could develop. Meanwhile a second team stays behind to watch satellite photographs for the first sign of a new low in the area. This team then flies through the new low as it moves out of its spawning ground and begins to intensify.

The aircraft taking part in the study carry a wide array of meteorological radars, augmented by a new doppler system, which allows observers to monitor the movement of moisture particles. A typical flight may last 10 hours. The scientists will drop sensors as they go. Expendable bathythermographs dropped from the aircraft hit the sea's surface, leaving a buoy-mounted transmitter, while a thermometer falls towards the sea floor, providing a profile of the temperature of the sea. Such experiments are crucial to the discovery of the circumstances of the ocean in which the lows form. ☐

Coming of age in Macaca

When food is plentiful, macaques are amicably promiscuous. But females are more choosy when life is hard, and the males respond by becoming both more aggressive and more virile

Julian Caldecott

Yarrow Robertson

Male pig-tails make better lovers?

IT IS soon after dawn in the Rif mountains of northern Morocco, and the overnight dew is beginning to evaporate from the leaves of the mixed oak forest which clings to the steep and craggy terrain. The shaking of branches, scuffling in the undergrowth and an occasional cooing call betray the presence of a group of foraging monkeys. They are Barbary macaques, *Macaca sylvanus*, members of the only nonhuman primate species in Africa north of the Sahara and the only species of macaque living wild outside Asia.

One of them, an adult female, moves into view, sturdy and brown-furred. Her most striking feature is a dark, glossy, rounded, pillow-like swelling across her buttocks. This mass of water-packed tissue has been formed temporarily under the influence of concentrated oestrogens in the female's blood, hormones secreted by her ovaries to prepare the body for reproduction. The great swelling is a sign that the female is within a very few days of ovulating. A week ago it was hardly visible, and a week in the future it will have collapsed to wrinkled flaccidity. Now, though, she is ready to be fertilised.

An adult male, of similar build to the female, is following her closely, and the two stop together in a patch of sunlight among the trees. He has been keeping close watch on her swelling as they travelled, and as she turns it prominently towards him in the unambiguous posture of sexual presentation, he mounts her at once. Standing pressed against her, he thrusts nine times in as many seconds, before pausing for a second or two at ejaculation and then dismounting.

After this quick bout, the female's first this menstrual cycle, she walks away from the male. He tries to follow, but as soon as a gap of several metres is formed between them, she is joined by another male and the first falls back. The newcomer had been waiting nearby for just this opportunity to consort, and the female accepts him without hesitation. Like the first, he is a member of her group and long familiar to her; within a few minutes they will mate—a quick copulation—and again the female will move on to a new partner. She will repeat this performance perhaps 40 times during the day, and likewise on subsequent days until her swelling subsides after ovulation. Each exchange of consorts will be amicable enough—relations between males are tolerant and relaxed—and most likely every male in the group, even those not yet fully adult, will mount the female at least once before she begins to gestate an offspring of one of them.

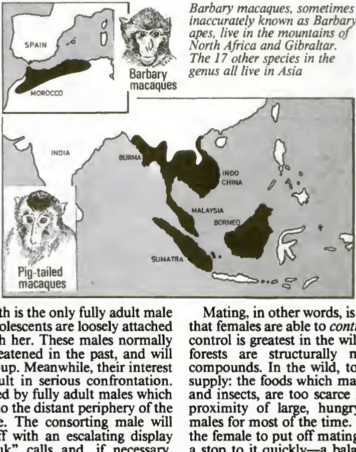
Meanwhile, it is mid-afternoon in Sumatra. The deeply textured canopy of a rainforest gleams in many shades of green under hot, equatorial sunlight. Distant grumbling clouds suggest heavy rain later; but now the forest is still, apart from the white noise of cicadas and the drift of falling leaves. A cooing call, very similar to that just heard in North Africa, rises and falls, to be answered by others from among the seedlings and miniature palms of the forest floor. A group of pig-tailed macaques, *Macaca nemestrina*, is spread widely in the deep shade below the trees. The monkeys are resting briefly, sifting carefully through leaf litter, overturning fallen wood, or pattering along to keep up with one another.

An adult female emerges from behind the curtain-like buttress of a giant tree, pauses and looks about her before doubling back out of sight. As she turns, she shows the huge red swelling which affects all the naked skin from the base of her tail to her vulva, surrounding the anus, and which, as with the Barbary macaque on the other side of the world, reveals the nearness of her ovulation.

Behind the tree, she joins her adult male. He is sitting, but even so his massive physique is clear—nearly double the female's weight; his shoulders are especially heavily muscled and deeply furred. He is surveying the middle distance, but glances at the female as she approaches. At once she turns to present her swelling to him, crouching and looking at him over her shoulder. He looks away. She holds her posture for a moment, before straightening and moving to squat next to the male, and beginning to groom him intensely. Shortly she presents again, and this time the male responds, mounting her for 13 pelvic thrusts in 10 seconds and then disengaging without having ejaculated. Over the next half hour or so, the cycle is repeated: the female grooms and presents in regular alternation, the male responds by mounting a dozen times with decreasing hesitation until at last he ejaculates. During

Mating is a brief affair for the Barbary macaques. A receptive female meets a male from her group; they huddle together, groom one another and mate, and the male ejaculates quickly. The female soon moves on to find another partner

this final mount, the female grimaces and reaches back to clutch the male's thigh with one hand; the male squeaks and is rigid for a moment, before sitting down and eating some leftover ejaculate.



Barbary macaques, sometimes inaccurately known as Barbary apes, live in the mountains of North Africa and Gibraltar. The 17 other species in the genus all live in Asia

For the rest of the day, and for subsequent days until just after ovulation, the female remains with the male as they travel near their group through the forest, she tirelessly maintaining their joint routine of grooming, presenting, mounting and occasional ejaculation. The female does not leave the male for another; but her swollen appearance is enough to excite and attract other males. The male she is with is the only fully adult male in her group; but one or two adolescents are loosely attached to the group and may approach her. These males normally avoid the adult male; they threatened in the past, and will eventually have to leave the group. Meanwhile, their interest in the swollen female can result in serious confrontation. These maturing males are joined by fully adult males which may have attached themselves to the distant periphery of the female's group from elsewhere. The consorting male will tolerate none, driving them off with an escalating display involving facial gestures, "bruk" calls and, if necessary, violent attack with his long canine teeth.

The Barbary and pig-tailed macaques clearly have different approaches to mating—even though they belong to the same genus, and are quite similar anatomically and in many other ways. Female Barbary macaques are promiscuous, forming very transient consortships, while female pig-tailed macaques are much more faithful to one male during prolonged consortships. Barbary macaque males, meanwhile, tend to ejaculate after only one mount of the female, and maintain friendly relations with one another, while pig-tailed macaque males mount repeatedly before ejaculation and are markedly antagonistic towards other males. There seem to be two quite different systems in operation.

Both of these systems seem to make sense separately. An important starting-point for the explanation of either system is the assumption that female macaques become not only highly sexually attractive to males as they approach ovulation, but also highly sexually motivated. There is increasing evidence for this, derived from captive experiments in which females are allowed to choose whether males have access to them, and also from observations of macaques held in large compounds and of wild groups. In these situations, females can avoid males if they are not willing to mate, and can approach them or allow their approach if they are. In such circumstances, and particularly in the wild, females tend to mate only near ovulation. This behaviour contrasts sharply with the behaviour of male and female monkeys held together permanently in small cages.

Mating, in other words, is linked to ovulation to the extent that females are able to *control* their sexual interactions. This control is greatest in the wild since there is more space, and forests are structurally more complex than cages or compounds. In the wild, too, there is the problem of food supply: the foods which macaques eat, principally ripe fruit and insects, are too scarce for females to tolerate the close proximity of large, hungry and behaviourally dominant males for most of the time. This scarcity of food encourages the female to put off mating for as long as possible, and put a stop to it quickly—a balance between hunger and sexual motivation which shifts in the latter's favour for only a few days in each menstrual cycle.

In both the Barbary and pig-tailed macaques, then, the female shows similarly obsessive sexual behaviour as she approaches ovulation; the difference is that in the Barbary she receives the ejaculate of many males while in the pig-tailed she receives that of only one. By exchanging males so rapidly, the female Barbary macaque creates a condition in which each male must ejaculate quickly if he is to stand any chance of fathering offspring. Yet each male has at least some chance of having fathered any baby that the female subsequently produces. Presumably because of this uncertainty about paternity, male Barbary macaques treat infants well, and the young monkey grows up in a society in which it often receives intense care (such as grooming and cuddling) from adult males. Even maturing males are not driven out of the group of their birth, but remain to breed within it. Because of this harmony, one assumes, the ratio of adult males to adult

Male Barbary macaques are kind to the children

females in groups of this species averages about 1:1; the added male mortality caused by fighting and the hazards of emigration and immigration is much reduced. Females do not transfer between groups either, so groups of Barbary macaques are probably very inbred. This inbreeding, in turn, should reinforce the solicitude of adult males for immatures—each adult male, if not the father, is undoubtedly closely related to the other adult males, and to their offspring.

It is hard to imagine an arrangement less like the Barbary macaque's than that of the pig-tailed. Here, since females remain with males in prolonged consortships, a male's reproductive success depends upon his being chosen as a sexual partner by a female. Thus males must simultaneously exert themselves to reduce the chance of other males being chosen—by excluding other males—and to increase the chance of themselves being chosen, preferably not just once but many times. Given the female pig-tailed macaque's way of mating, the male must reward the female's sexual advances adequately to sustain her preference for him as a partner in the future. Male potency must be maintained, and this is achieved by deferring ejaculation and ejaculatory fatigue —hence the long series of mounts before ejaculation.

Monogamy is lethal

With the emphasis in the pig-tailed macaque firmly on male competition with one another, it is not surprising that relations between males are rather strained. Maturing males are pushed to the peripheries of their groups and strange males are repelled. This antagonism encourages males to leave the groups and leads to higher mortality among males. Adult sex ratios within groups of pig-tailed macaques are normally very skewed in favour of females. And since male monkeys invariably leave the groups of their birth and mate elsewhere if lucky, pig-tailed macaque populations are probably far more outbred than those of Barbary macaques.

If the Barbary and pig-tailed macaques have such different systems of mating and society, what of the other 15 or so species in their genus? Considering for how long macaques have been studied in various ways—in captive, semi-wild and wild conditions—surprisingly few species are well-enough known for their societies to be compared with the Barbary's and pig-tailed's. But one would expect various features to go together: ejaculation after a single mount with brief consortships, amicable inter-male relations, a lack of male emigration and an equable adult sex ratio, contrasting with ejaculation after several mounts with long consortships, antagonism between males, common emigration of males and a skewed sex ratio among adults. These features do indeed seem to be associated, so that the better-known macaques can be assigned fairly confidently to two groups. In one group, aligned with the Barbary macaque, are the south Indian bonnet macaque, *M. radiata*, and the Southeast Asian bear macaque, *M. arctoides*. In the other, standing alongside the pig-tailed, are the south Indian lion-tailed macaque, *M. silenus*, the Indian rhesus macaque, *M. mulatta*, and the Japanese macaque, *M. fuscata*.

Why should the genus be divisible in this way? Put another way, why should the females of some species mate so as to encourage their societies to contain many males (sex ratio near 1:1), while others mate to achieve the opposite effect? The answer seems to lie in a subtle cost-benefit analysis. Adult males within groups compete with females and their offspring for food. But on the other hand they may offer protection against predators or other benefits of care. The reproductive interests of females may best be served by different sex ratios in different environments. All else being equal, Barbary macaque-like societies should be found in species adapted to relatively food-rich habitats, and pig-tailed macaque-like ones in those adapted to poorer habitats.

It is very difficult to measure the "quality" of a macaque's habitat. But at least some variables affecting it have now been identified. Macaques are forest-dwelling animals, and forests are better or worse homes according to their productivity (the amount of new growth each year which might in principle be eaten), their seasonality (is there food year-round?), their floristic composition (affecting when foods are produced and in what form), and their phytochemistry (the proportion of potential food which is denied to macaques because it contains poisonous or indigestible chemicals). These features often seem to be interrelated: for example, floristic composition affects phytochemistry because different groups of plants have different chemical attributes. And productivity affects phytochemistry because forests struggling to grow in unfavourable conditions invest more in chemical defences.

Looking at the immense area of Asia inhabited by macaques, from Pakistan to Sri Lanka, China, Japan and the outlying islands of Indonesia and the Philippines, the genus has clearly occupied a very great range of forest types. Both latitude and altitude affect the quality of these forests as habitats for macaques, with colder, drier and more seasonal forests offering more uncertain supplies of food. In South and Southeast Asia another important variable is the abundance of trees belonging to the family Dipterocarpaceae—the more dipterocarps, the worse the forest. Dipterocarps are inherently rather inedible, being resinous and having wind-dispersed seeds. They also fruit only sporadically and *en masse*, with long barren periods between, and they are associated with generally unfavourable forest phytochemistry.

Taking all this into account, it looks as though bonnet and bear macaques live, as predicted, in regions whose forests are relatively hospitable, while pig-tailed, lion-tailed, rhesus and Japanese macaques all live in poorer habitats. At present, this amounts only to a hint of a relationship between habitat and macaque society, and much more needs to be discovered before any such relationship is established. Some information seems to contradict the hypothesis, in any case: the Barbary macaque itself, for instance, can hardly be said to occupy a particularly favourable habitat in the North African mountains. This species, however, has been displaced from most of its range in the hospitable Mediterranean lowlands by recent human activity, so the picture is clouded, perhaps beyond resolution. Meanwhile, the long-tailed macaque, *M. fascicularis*, makes a very ambiguous contribution to the debate —reports have it living in rich forests, with a society akin to that of rhesus and Japanese macaques, and with males which ejaculate after single and multiple mounts with almost equal frequency. But this species occupies such an enormous geographical range—from continental Southeast Asia to the distant reaches of the Malay Archipelago—that there is plenty of scope for differences between populations.

Until much more research has been done in the wild, many questions will have to remain. But it is quite likely that some of their answers will never be found, since the forest homes of the macaques are being rapidly destroyed by people. Several species may soon cease to exist in the wild, and even the commoner distributed macaques will end up living in scattered, disturbed and unnatural locations. At present, at least this much can be said: the macaques are a much more diverse genus than has usually been thought, and it is no longer possible to assume that species can stand in for one another in research projects, nor that captive studies can substitute for field work. How much more will ever be said depends on the diligence with which we conserve and study these fascinating monkeys. ☐

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The main source of nitrate in the groundwater: a million tonnes of nitrogen are added as fertilizer to Britain's fields every year

Farmers Weekly

Whatever happens to nitrogen?

The cycling of nitrogen through soil and air and living things affects the productivity of crops, human health, and the environment at large. But, as a Royal Society study group now reveals, the details of its peregrinations are largely unknown

Colin Tudge

PEOPLE need nitrogen: not in the simple gaseous form in which it makes up 80 per cent of the atmosphere, but as a constituent of protein and of genes. Indeed, Britain's 56 million people ingest some 300 000 tonnes of it per year. But people can also be poisond by it, principally in the form of nitrates in the water, which in the short term affect the blood and in the longer term may possibly promote cancer. Plants and fish are poisoned by rain made acid partly by oxides of nitrogen, and buildings are corroded by it. This is why the toings and froings of nitrogen, in and out of soil and water and air and living things, should be understood and controlled. But the astonishing truth now revealed by the Royal Society study group on *The Nitrogen Cycle Of the United Kingdom* is that although there are masses of data, the fate and activities of nitrogen are not well understood. The group, led by Professor W. D. P. Stewart of the University of Dundee, concluded that what's needed above all is research; a great deal of it, done collaboratively between government departments and industry, and universities and institutes.

The atmosphere merits particular study. It giveth to the nitrogen cycle, as the gas (N_2) is incorporated into soluble nitrates and ammonia in the soil or water; and it taketh away, as those same compounds are denitrified, mainly by soil bacteria. What matters is not nitrogen itself but the ammonia and oxides of nitrogen that enter the atmosphere in vast amounts from farmland, towns, freshwater and sea.

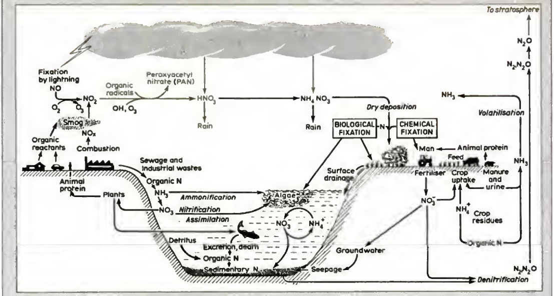
Perhaps the greatest unknown of all is the fate of the ammonia that volatilises into the atmosphere. Some (an unknown amount) comes from alkaline fresh water and the sea, but most comes from animal excreta and sewage sludge, and ammonium fertiliser. Some of what escapes from the soil is recaptured by the plant canopy, but how much is unknown. Ammonia may in part help to neutralise acid rain; the extent to which it does so is also unknown. Again the study group calls for extensive research.

More obviously important are the oxides of nitrogen. Once they were seen as a threat to the ozone layer in the outer atmosphere, which shields the Earth from too much ultraviolet radiation; but such a threat, says the group, is not likely to be significant "now or in the foreseeable future". What is significant is that acid rain can no longer be attributed solely to oxides of sulphur; oxides of nitrogen, dissolving to form nitric acid, now seem to be responsible for about a third of rainfall acidity in northern Britain. Where exactly those oxides come from is, again, not known. Some obviously comes from the burning of fossil fuels, some is released from the sea; and some presumably comes from agricultural land—but how much, and whether the amount is affected by changing practices of agriculture, is "scarcely known either".

The Royal Society study group calls here for a "detailed study" to provide basic information without which "government could take policy decisions related to the acidification of the environment which cannot be justified scientifically or economically". The group wants this information quickly ("within five years") and urges the Royal Commission on Environmental Pollution to "pay particular attention to the problem of acid deposition as part of its current study of air pollution, or as a separate issue". In truth, the role of nitrogen oxides in acid rain took the group by surprise. When it convened in 1979 such oxides were not considered important.

The fate of nitrogen in Britain's fresh water is better understood. It is clear that most of the maverick compounds of nitrogen coming from the atmosphere and the land pass through Britain's rivers, lakes and aquifers on their way down to the sea. Indeed the rivers deliver more than 350 000 tonnes of nitrogen a year to the sea from land and sewage.

The nitrogen cycle



In principle, and in qualitative detail, the fate of nitrogen as it circulates from air to soil to living things and back again, is well understood. But the fate of the environment depends upon how much goes where, under what conditions; and this requires a great deal of research

Nitrates are the potential problem; in high concentration, they affect human health. The World Health Organisation recommends, and the EEC demands, that potable water in Europe should not contain more than 11·3 milligrams of nitrate nitrogen per litre. Though the rivers of Britain "are, in general, among the cleanest in the EEC" it is clear that in some the levels of nitrate "are steadily increasing". But even this information is not as clear as it should be, because there are few long-term records of nitrate levels in fresh water, but those that there are show a 50 to 400 per cent increase over the past 20 years. At least now there is a national network of stations that monitor water nitrates, which the group strongly supports.

The group sees no need for panic: there is "no immediate problem relating to nitrate level in waters which cannot be adequately handled by the water industry". But it sees no room for complacency either. Thirty per cent of Britain's water supply comes from groundwater, in which the concentration of nitrogen in some cases has "risen substantially" over the past 10 to 15 years. Furthermore, "in many areas equilibrium levels have not been reached". Specifically, nitrate nitrogen can now be observed trickling its way down through the aquifers into the main bodies of groundwater, perhaps to reach a maximum concentration in 20 to 30 years—sometimes to take the nitrate levels well above the EEC maximum. In that 20 years a great many more people will have moved into precisely those areas in the Midlands and Southeast that are most likely to be the most polluted.

But even the traditionally pure waters of the uplands are not safe. They now carry the bulk of Britain's two million hectares of forest, and this could double, eventually to cover 12 per cent of Britain's area. It is clear that such afforestation can have great effects on the flow of water in general, and its content in particular. Thus, land covered in trees loses water more quickly than land that is not. It seems, too, that water running off the afforested catchments may be more acidic than from non-afforested—perhaps because forests concentrate acidic pollutants from the atmosphere, including the oxides both of sulphur and of nitrogen.

Engineering may provide some of the answer to all this; including pumping clean water from places where people do not live, to places where they do. In addition, technologies are already being developed to remove nitrate from water—although reducing the amount to acceptable levels could cost £200 to £1600 million over the next 20 years.

So again the group calls for research, including better models to predict how nitrate levels are liable to increase. Also to be tackled are such problems as "the extent to which N_2 and nitrous oxide are lost from fresh waters by denitrification" and the effect that nitrate in water and food has upon human health, including its possible influence on cancer.

The fact that afforestation may have such profound effects on waters, and particularly the effect of commercial forests upon upland water, has only recently been appreciated. The problem calls for "urgent attention" from the Forestry Commission, the water industry, and the government departments and research councils for agriculture and environment. The long list of particular topics that need study include the extent to which nitrogen fertiliser affects the growth of trees, and the extent to which it also leads to deficiencies of boron and copper, which would reduce the resistance of trees to the rigours of winter. The group also asks whether alder trees, which fix nitrogen (see below), or leguminous plants grown as understorey among the trees, might increase fertility without such dangers of run-off.

The sea is the ultimate receiver of nitrogen, and again the consequences are largely unknown. It does seem clear that Britain's estuaries are not unduely polluted by it; the contributions that sewage makes to the nutrition of estuarine plants and animals are "only rarely negated" by the toxins with which sewage is sometimes spiked. More research is needed, however, into the "nutrient cycling processes" within estuaries, including the relationship between the cycling of nitrogen and that of carbon.

The outstanding question in the seas is the effect of nitrogen on the plants of the plankton. To what extent does phytoplankton need the quota it receives from the land? Would it be deficient in summer without it? What of the influence of the planktonic bacteria, which convert organic nitrogen into mineral form, or of zooplankton? Plankton forms the base of the food chain of the sea, and the coastal and continental shelf waters around Britain provide some of the richest fishing grounds in western Europe. Yet in recent years the plankton of the North Sea has declined. Nitrogen's role is again unknown, but it is clearly time to find out.

But the greatest man-made influence on the nitrogen cycle, and the one over which human beings have most control, is agriculture. This, appropriately, has the biggest slice of the study group's report. About three-quarters of Britain is farmland. This land received about 2 million tonnes of nitrogen in 1978, of which a small amount (about a third of a million tonnes) came from biological fixation, roughly the same amount from precipitation, and a small amount from imported animal feedstuffs. But the bulk—1·15 million tonnes—came from artificial fertilisers. By 1981 artificial fertilisers were contributing 1·34 million tonnes; indeed this input has increased by 4 to 5 per cent annually for the past 10 years, and the group anticipates that it will continue to rise. Crops also obtain nitrogen from animal excreta, and from organic matter in the soil.

The good side of all this is that Britain produces enormous amounts of food: we meet two-thirds of our requirement for temperate crops, our output is rising by 3 per cent per year, with exports doubling between 1971 and 1980. The bad side is that about 150 000 tonnes of nitrate nitrogen leaches out, with the amount varying greatly from year to year and from soil to soil; and an unknown quantity disappears into the atmosphere.

The nitrogen loss is wasteful and potentially dangerous, and the question is how to reduce it. The group found, for a start, that more than half the artificial fertiliser applied goes on grassland and that little of this is leached. Grass, after all, is permanently in residence and its roots (there are several km of root under every square metre) allow very little to escape. The greater problem is in arable land where the crops come and go. Such land received 440 000 tonnes of fertiliser nitrogen in 1981 and lost a third of it by leaching.

There are solutions, however, or at least ways of reducing the problem. The key is to match nitrogen inputs to the crop's ability to use it. Breeding helps, and the group suggests further exploitation of high-yielding varieties that are particularly good at taking up nitrogen. Timing, too, is crucial, and the group welcomes the trend towards winter cereals—barley and wheat sown in the autumn, to stand throughout the winter and race away with the first sun of spring. With winter crops the ground is covered for longer, and well filled with roots, and leaching by winter rains is minimised.

On the other hand, not enough is known about how much nitrogen is lost from particular crops in particular circumstances. In particular, there is scope for more detailed mathematical modelling: after all, the behaviour of nitrogen salts in soils obeys laws of simple (or at least understandable) physical chemistry, and even uptake by plants follows straightforward rules. "Accordingly," says the group, "we recommend that increased attention be given to the further development of predictive models which can be used to optimise the responses of crops to fertiliser nitrogen while minimising nitrogen fertiliser losses."

The vast contribution of organic nitrogen, both to the growth of crops and to pollution of air and water, is also little understood. Yet British agricultural soils contain about 200 million tonnes of organic nitrogen. The store is 150 times greater than that applied annually as fertiliser.

The organic nitrogen under grassland can be particularly significant. Thus, when old grassland is ploughed, much organic nitrogen is broken down into inorganic forms. The inorganic nitrogen may of course nourish subsequent crops; but there may be more than these crops can take up. After the Second World War a great deal of old grassland was ploughed, as the British government resolved never again to be short of food in times of blockade. This, says the group, "has contributed to the present nitrate burden of certain aquifers". In contrast, the nitrogen fertiliser added to grassland, and the increased stocking rates, "may well increase organic nitrogen levels in the soil". As the group says: "We see a need for sustained research... aimed at quantifying the breakdown and build-up of organic nitrogen in soil."

Then again, animal excreta is potentially valuable or potentially highly pollutive depending, largely, on whether it is spread innocuously by animals as they graze or deposited in confined spaces. The latter is the case with the excreta produced by almost all Britain's pigs and poultry, and half its cattle. This excreta contains about 480 000 tonnes of nitrogen, which is equivalent to a third of the nitrogen fertilisers applied. But it "contributes relatively little to the nitrogen taken up by the UK crops", and "there is substantial scope for reducing nitrogen losses during the handling, storage and application of organic manures". Research is already in train into ways of using manure efficiently, which the group recommends should be "actively continued".

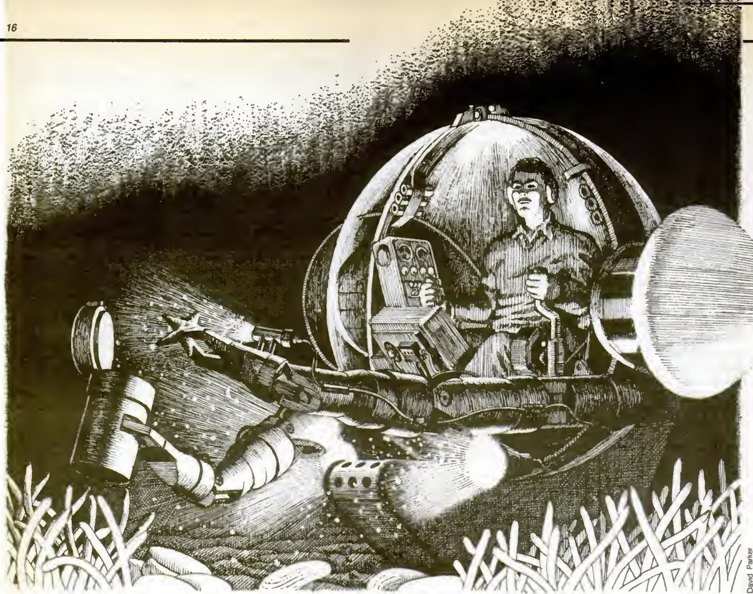
Farmers Weekly/UCW Aberystwyth

Clover can help to reduce nitrate pollution, by adding fertility without fertiliser. But we need to breed new clovers that can produce effective root nodules (left) even in adverse conditions

The most benign way to add nitrogen to the soil is by biological fixation. This is the conversion of gaseous nitrogen in the atmosphere into soluble compounds, notably nitrates, that plants can take up as nutrients. It is effected by bacteria, some of which live free in the soil, and some of which (notably *Rhizobium*) live in nodules of the roots of leguminous plants, such as clover and beans, and of a few non-leguminous plants, such as alder. Biological fixation provides soils in Britain with 0·2 to 0·4 million tonnes of nitrogen a year, and some legumes can fix 200 to 300 kg per hectare. Yet biological fixation is contributing less and less. For one thing, heavy applications of nitrogen to a mixed sward of clover and grass will inhibit fixation, and also encourage the grass so much that it overshadows the clover. Great efforts have been made to improve *Rhizobium* strains over the past 30 years, "but this has had little impact on UK agriculture". Genetic engineering may well do wonders for the process in decades to come, but in the short term the group recommends a few practical approaches. One is to find "reliable and profitable" leguminous crops to introduce into arable rotations. Another is to make "more effective use" of clover in pasture, particularly in the uplands, and marginal areas. A third is to develop legumes that will grow effective root nodules in acid soils (where it is often uneconomic to apply nitrogen fertiliser) and to find associations of legumes and *Rhizobium* that will go on fixing nitrogen even when they are assailed with extra loads of fertiliser. More research again, then; and more research, too, "on fundamental aspects of biological N_2 fixation".

One trouble with research into the nitrogen cycle is that it inevitably involves many different disciplines. Another is that it can be unglamorous. What is certain, however, is that it needs to be done. ☐

The Nitrogen Cycle of the United Kingdom is a Study Group Report published by the Royal Society, London, at £12·50



David Parker

A gentle touch for the ocean floor

Audio feedback can tell the operator of a prototype underwater manipulator the difference between steel, concrete, wood and rubber

Dag Pike

IT IS NEVER going to be easy to work deep beneath the surface of the oceans. The environment is dark, dangerous, hostile. The problems are legion: how to reach the desired site, how to manoeuvre once there, how to manipulate tools and objects with the required strength and delicacy. Both operators and machines are often working at the limits of tolerance. Now a prototype submersible has been produced which promises to open up new vistas for underwater exploration and maintenance.

The prototype is the creation of Graham Hawkes, a British designer at Deep Ocean Engineering of California. His Deep Rover is built for one or two operators. Its clear acrylic plastics hull will give almost all-round vision at depths up to 1000 metres, and manoeuvre like an underwater helicopter. And it has manipulators so sensitive that blindfolded operators have been able to tell the difference between steel, wood, concrete, rubber and even painted surfaces. The tactile sensors relay information audibly, and are said to be able to detect the vibrations of fluid flowing through lines.

Hawkes was the engineer behind the WASP diving suit and MANTIS underwater vehicle that set the pattern, in the late 1970s, for future developments of one-and two-operator submersibles for work in deep waters. Recognising that a submersible is only as good as the tasks it can carry out, he has now developed one where people can work efficiently at depth in a pressure chamber. The challenge was to provide a wide field of vision, in contrast to the portholes of earlier submersibles, and to develop a manipulator which gives a close approximation of human touch.

The philosophy behind the vehicle is that it should go as deep and as fast as possible whilst remaining simple, rugged and safe. Compared with other submersibles there is ample space to give comfort during the planned 4-6 hour dives. The outside diameter of the plastics sphere is 1·67 metres with an inside diameter of 1·35 metres. The two hemispheric acrylic sections seal to a central, cast-aluminium ring which carries all the through-hull electrical, gas and mechanical connections. The front hemisphere opens for access and servicing.

The main chassis of the Deep Rover is of aluminium, but the remainder of the external structure is almost entirely in plastics, mainly black UV-protected polypropylene in thick sheet sections and the use of this material has allowed the payload to be increased by 76 kg compared with conventional aluminium structures. The plastics are also more resistant to shock impact, and it is expected that further experience with these materials will lead to even greater savings in weight without sacrificing strength.

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Four variable-pitch electric thrusters are fitted, to give a thrust of 205 kg in forward or reverse and 90 kg vertically. The Deep Rover is designed to operate either free or tethered. In free operations, battery power is sufficient for up to six hours of operation, with emergency power for 150 hours.

Although Deep Rover represents a significant advance in free-ranging submersibles for a single operator, the most significant advance is its manipulators. Hawkes set out to develop a manipulator which would come close to human ability in most respects and which would exceed it in others, notably its lifting power, torque and reach.

The arms of the manipulators are built up in modular fashion, each unit allowing a 110° range of movement, normally either horizontally or vertically and is hydraulically driven. The standard arm comprises six units ending in a wrist and hand with 210° of movement. The hand is an articulated pincer grip which grips at four points. The main jaws and the tips are independently operated; the hydraulic pressure operates first on the main jaw. When the main jaw touches the object, the movement is then switched to the tips: only when all four points are in contact is full pressure applied. An even balance of pressure is maintained between the four points. The ability of the jaws to grip objects off the jaw axis makes life much easier for the operator.

The arm units are constructed largely from graphite-loaded nylon with stainless steel and aluminium fittings. The arm can lift up to 110 kg and the rotation torque is 135 NM. The standard arm can work through a 3-metre radius.

In addition to their mechanical capabilities, the manipulators have sensors. Audio tactile feedback from the jaw tips can allow an experienced operator to identify different materials from their texture and hardness as well as locate cracks. If it is neccessary, this can all be done blind.

An overall view of the work area is provided by a wide-angle camera above the capsule and wrist-mounted cameras on each arm. Each wrist camera can observe the other arm as well as provide a close-up view of areas that are normally inaccessible. The arms can be manipulated so delicately that their movement cannot be detected visually. An experienced operator can position the arm with an accuracy measured in hundredths of millimetres. The force of grip can also be judged and to complete the range of sensory perception, a hydrophone transmits ambient noise to the operator.

In designing the control systems for Deep Rover, the aim has been to give the operator an "instinctive" integration of the propulsion and manipulator motions. These two controls are separated into left and right, each governing the respective sides of the vehicle. The controls lie where arm-rests would be fitted to the seat, and forearm, wrist, fingers and thumb are used for control.

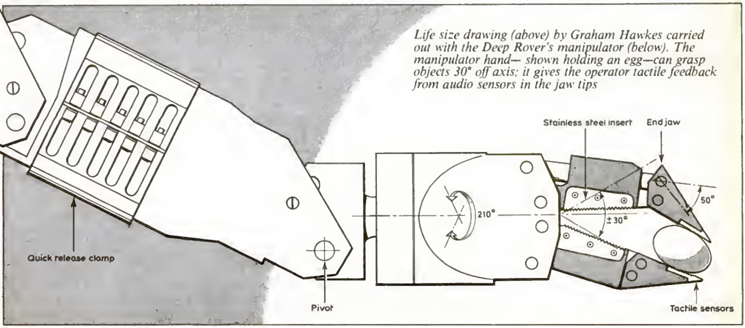
Thrust is controlled with the forearm; pushing the left forearm forward, say, will move the left side of the vehicle forward. Vertical movement is controlled by vertical movements of the forearm. A simplified wrist-and-thumb motion governs the manipulator arms: the thumb is used to apply force, while the grip of the operator's forefinger governs the hands on the manipulator. Smooth and coordinated movements of both craft and manipulator arms are possible.

The modular construction of the manipulator has been extended to the construction of Deep Rover itself, Allowance has been made for future developments of equipment for special operations, for example. And perhaps the biggest advantage of the modular concept is the chance to vary the type of pressure chamber. One option under development is a sphere with thinner walls: this would halve the depth at which the craft could operate, but the increase in internal volume would allow a second crew member.

Greater operating depths are planned. Acrylic materials will be suitable for pressure spheres for depths up to 2 kilometres but beyond this alternative materials have to be found. One possibility is the use of transparent ceramic materials: these could allow Deep Rover to descend to 6000 m and ultimately perhaps to 10 000 m. For the first time, it will be possible to explore the oceans unfettered, Dr Sylvia A. Earle, a partner with Hawkes in Deep Ocean Engineering, says that this is the most exciting challenge, but Deep Rover is likely to have equal value in commercial operations.

The machine's aptitude for delicate operations in deep water will allow even deeper offshore oil and gas exploitations. Already, an unmanned version of Deep Rover, called Rig Rover, is carrying out maintenance work previously possible only with divers. Fitted with the Hawke sensory manipulators, Rig Rover can operate from the surface, pointing the way to subsea oil wells in deep water without the need for expensive platforms ☐

Dag Pike is a marine journalist.



Life size drawing (above) by Graham Hawkes carried out with the Deep Rover's manipulator (below). The manipulator hand— shown holding an egg—can grasp objects 30° off axis; it gives the operator tactile feedback from audio sensors in the jaw tips

Universe gets older again

John Gribbin

A NEW analysis of the kind of data recently interpreted as implying that the Universe is much younger than we used to think gives a value more in line with previous ideas. However, since there are two schools of astronomical thought on how the data should be interpreted, all we can say for sure is that somewhere between 10 billion (10^{10}) and 20 billion years have elapsed since the big bang.

Virgo galaxies mislead on universal age

Kit Peak National Observatory

All estimates of this kind depend on estimates of the distance scale of the Universe—how far it is to other galaxies and clusters of galaxies. In the expanding Universe, a parameter called Hubble's constant relates the distance of a galaxy to the velocity with which it is seen to be receding. Velocity is easily measured from the red shift in spectral lines in light from the distant galaxy. So measuring the distance from us to a few relatively nearby galaxies would calibrate the red shift/distance relation, providing a yardstick for the Universe and also indicating the minimum age of the Universe, since galaxies now flying apart must have been packed together in the big bang at a time related to the inverse of the Hubble constant.

That crucial step—measuring the distance from us to relatively nearby galaxies—is, however, easier said than done.The first successful approach to the problem depended on indentifying certain types of star, the Cepheid variables, whose absolute brightness could be inferred from the way they pulsate. Simply measuring the observed brightness then gave a handle on the distance to them, and by looking at Cepheids in other galaxies astronomers came up with a Hubble constant of around 50 km /sec/Megaparsec, implying an age of the Universe of roughly 20 billion years.

This interpretation has long been championed by Allan Sandage, of the Mount Wilson and Las Campanas Observatories. But another point of view, espoused by Gerard de Vaucouleurs, of the University of Texas, Austin, sees the evidence as more consistent with a Hubble constant of 100, in the same units, and an age for the Universe of 10 billion years. This is uncomfortably short, since standard astrophysical theory suggests that many galaxies and some stars are themselves older than 10 billion years. Obviously, a star cannot be older than the Universe.

And yet, in the past couple of years, the de Vaucouleurs camp had gained strength from a new technique which measured galactic distances independently of the Cepheid variable method. This technique, called the Tully-Fisher method, depends on estimating the mass of a galaxy from measurements of its radiation at 21 cm, the hydrogen line. The width of this radio "line" indicates overall mass, and, assuming all bright stars radiate in much the same way, that gives a guide to overall brightness, and hence distance. A galaxy twice as massive as our own ought, on the simplest picture, to be twice as bright.

This technique, applied to the Virgo cluster, one of our nearest cosmological neighbours, gave a distance of 16 Megaparsecs, leading to the surprisingly low estimate for the age of the Universe. Now, however, Sandage and G. A. Tammann, writing in *Nature* (vol 307, p 326), query the basis of the estimate.They argue that the Virgo cluster is too close to be used as a guide to cosmic distances, that the motion of our Galaxy and our Local Group of galaxies is distorted by the gravitational pull of the Virgo cluster—indeed, we may be part of that cluster—and that for a reliable calibration we have to look further into space, to the Como cluster, some 140 Megaparsecs away according to the same kind of evidence. That gives them, once again, a value close to 50 for the Hubble constant, and an age of the Universe, at 20 billion years, comfortably older than the oldest known stars.

There is an element of friendly rivalry between de Vaucouleurs and Sandage which has led some headline writers to profess a "dispute" over the age of the Universe and imply a bitter wrangle. In fact, it is one of the more remarkable achievements of modern science to have pinned this number down to within a factor of two. The "dispute" merely represents fine tuning, and although each camp stands by its calculations, at present Sandage must have the edge, simply because of the difficulty in explaining the existence of 20-billion-year-old stars if the Universe is "only" 10 billion years old. ☐

Laundered marrow helps transplants

IMMUNOLOGICAL rejection is the major hazard of organ transplantation. Bone marrow transplants are different. Because some of the body's immune capacity resides within the bone marrow, there is a risk that the donor bone marrow will try to reject the patient. This "graft-versus-host" disease shows itself as a severe rash diarrhoea and liver damage. It renders the patient immune deficient and is frequently fatal. Because of it, bone marrow transplants, which have markedly improved survival in acute leukaemia, aplastic anaemia and a group of rare congenital enzyme deficiencies, are really only feasible between siblings with the same tissue type. Even so, graft-versus-host disease occurs to some extent in between 20 and 80 per cent of such transplants.

Conventional treatment with corticosteroids and the cytotoxic drug methotrexate has recently been superseded by the new immunosuppressant drug cyclosporin A. However, even this is not without its problems, leading to kidney damage in some patients and restricting the range of antibiotics that can be used while the bone marrow is recovering after the transplant.

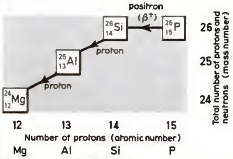
A different approach is based on the observation that bone marrow transplants in small rodents do not lead to graft-versus-host disease unless spleen cells are added to the marrow. This seems to be because rat or mouse marrow contains very few T-lymphocytes. These T-cells are responsible for recognising foreign matter and controlling the production of antibodies against it. Attempts have therefore been made to remove T-cells from human marrow before transplantation. This can be done by making specific antibodies (monoclonal antibodies) against the T-cells and "subtracting" them from the marrow. Dr Grant Prentice from the Royal Free Hospital in Hampstead has successfully "laundered" marrow from 13 patients using a "cocktail" of three monoclonal antibodies to remove the T-lymphocytes.

Even more encouraging is a new rat monoclonal antibody produced by Dr Hermann Waldman of the Department of Pathology at Cambridge University. Called CAMPATH-1, it is an immunoglobulin M antibody which is cytotoxic for all human lymphocytes when used with human complement. Five bone marrows (four in Israel and one in West Germany) have been successfully "laundered" with it and engraftment has swiftly followed. Early work at the Hospital for Sick Children in London suggests it may aid transplants from incompatible donors. ☐

Phosphorus-26 shows novel decay

PHYSICISTS working at the Lawrence Berkeley Laboratory in California have discovered a second example of a new form of radioactivity. Almost a year ago they reported their observation of the "beta-delayed two-proton decay" of the nucleus aluminium-22. Now they have discovered a similar phenomenon in the decay of phosphorus-26.

Radioactive decay in general reflects the attempts of an unstable nucleus to reach a more stable configuration of protons and neutrons. It can do this in a variety of ways which involve adjustments in the relative numbers of protons and neutrons: the optimum ratio minimises the overall energy of the nucleus and thereby makes it stable. In normal beta decay, a neutron (or proton) converts into a proton (neutron), emitting an electron (positron) together with an antineutrino (neutrino). In the beta-delayed two-proton decays observed at Berkeley, the beta decay, signalled by a positron, is followed immediately by the emission of two protons.



Beta-delayed two-proton decay of ^{26}P transmutes the nucleus to ^{24}Mg. Beta decay alone would stop at ^{26}Si

In their most recent work Joseph Cerny and his colleagues have studied protons emitted by decaying phosphorus-26. This is a highly unstable nucleus with 15 protons and 11 neutrons. The common form of phosphorus has 16 neutrons, its stability being ensured by the approximately equal number of neutrons to protons. The team obtained the ^{26}P by bombarding silicon-28 with a beam of helium-3, in a reaction that produces ^{26}P together with a proton and four lone neutrons:

$$^{28}_{14}\mathrm{Si} + ^{3}_{2}\mathrm{He} \rightarrow ^{26}_{15}\mathrm{P} + ^{1}_{1}\mathrm{p} + 4(^{1}_{0}\mathrm{n})$$

They then intercepted protons from the decays of the ^{26}P with a special "telescope" of silicon detectors (*Physics Letters*, vol 1338, p 146).

The energy spectra of the emitted protons revealed two peaks, which the researchers associate with the sequential decay shown in the figure, which terminates in the ground state (lowest energy state) of the nucleus ^{24}Mg. In the process, the ^{26}P nucleus converts one proton to a neutron and loses two further protons, thus changing its proton-neutron ratio significantly to form ^{24}Mg which contains equal numbers of each nucleon:

$$^{26}_{15}\mathrm{P} \rightarrow ^{26}_{14}\mathrm{Si} \rightarrow ^{25}_{13}\mathrm{Al} + ^{1}_{1}\mathrm{p}$$
$$\text{and } ^{25}_{13}\mathrm{Al} \rightarrow ^{24}_{12}\mathrm{Mg}$$

The decay of ^{26}P is simpler, the team says, than that observed for ^{22}Al. In that case the complex proton spectra made it difficult to see through which path the beta-delayed two-proton decay occurred (*Physical Review Letters*, vol 50, p 404). □

The early history of the mammals

ACCORDING to current opinion, the mammals are divided into two major groups, the therians (which include nearly all living forms—the marsupials and the placentals), and the monotremes (the duck-billed platypus and echidna of Australia and New Guinea). These two groups are supposed to have had a long independent history after they arose from mammal-like reptiles 210 million years ago. Indeed, the monotremes, which lay eggs, have been regarded by some people as living mammal-like reptiles. During the age of the dinosaurs (210-65 million years ago) there were several groups of primitive mammals, and these have been assigned somewhat arbitrarily to the therian or to the monotreme line. This has reinforced the impression of an independent history for both groups during that time.

In recent years, several authors have questioned this picture. Monotremes share an embarrassing number of highly complex anatomical specialisations with therians, and it is hard to imagine all of them arising in parallel. Tom Kemp of the Zoology Department, Oxford University has reconsidered this whole question, and he concludes (*Zoological Journal of the Linnaean Society*, 1983, vol 78, p 353) that the monotremes share a number of advanced characters with the modern therians that are absent in most early fossil mammals. The implication is clearly that the living groups of mammals do not represent two main lineages with over 200 million years of independent evolution, but that they share a more recent ancestor.

Monotremes have the same complex system of ear ossicles that are present in humans and all other therians: the incus, malleus and tympanic bones. Kemp lists a further seven features of the skull and skeleton which are shared specialisations of monotremes and modern therians, and which are absent in the early mammals. He concludes, reasonably, that the monotremes and therians form a monophyletic group (they share a common ancestor). Most of the early fossil mammal groups fall outside that monophyletic group.

If the monotremes and modern therians did not diverge 210 million years ago (near the end of the Triassic period), when did they split? The oldest identifiable monotremes are only a million or so years old, although there are a couple of possible platypus teeth from the Miocene of Australia (about 30 million years ago). The oldest known marsupials and placentals are known from the end of the early Cretaceous (about 100 million years ago) of Texas. There are further fragmentary remains from the early Cretaceous which might fall in the monotreme-therian assemblage. The two groups of living mammals may have diverged as little as 120 million years ago. □

Nervous growth

GIVEN the right conditions there seems to be no reason why nerve tissue should not be able to regenerate readily and efficiently. After all, salamanders have the trick down to a fine art. But peripheral nerves in humans, if they regenerate at all following injury, they do so only at a very slow rate. Now Suzanne Kilmer and Richard Carlsen of the University of California at Davis have found that certain substances can boost the rate of regeneration in nerve tissue.

Injured nerve tissue is always found to contain raised levels of the enzyme adenylate cyclase, which catalyses the conversion of the high energy compound adenosine triphosphate to cyclic adenosine monophosphate (cAMP). Kilmer and Carlsen excised a chunk of the sciatic nerve axon from frogs (*Rana pipiens*). There was no difference in cAMP levels in the tissue after 2 days, compared with normal nerve. After 7 days however, cAMP was twice as high as in experimental tissue. To establish firmly the apparent link between cAMP and nerve regeneration they exposed the injured nerve to a potent activator of adenylate cyclase, called forskolin. This resulted in a 40-fold increase in the level of cAMP in the tissue which persisted for 1 hour. But more interestingly, subjection of the tissue to forskolin also produced a sustained 40 per cent increase in the rate of regeneration of the nerve. □

Blonds, beware!

PEOPLE with blond hair are seven times more likely to suffer malignant melanoma, a particularly malignant skin cancer, than people with black hair, according to a new study carried out by J. M. Elwood and J. C. G. Pearson of the University of Nottingham and R. P. Gallagher and colleagues at the Cancer Control Agency of British Columbia in Vancouver, Canada (*British Medical Journal*, vol 288, p 99).

The tumour arises from the pigment which produces melanocytes in the skin, and is rapidly increasing in almost all white populations. Among the factors known to predispose to the tumour are sunlight and atypical skin moles.

Other links revealed by the study include light colour of unexposed skin and severe freckling, carrying a relative risk of malignant melanoma of 2·4 and 2·1 respectively. These associations were independent of ethnic origin and amount of exposure to sun. □

Smoking and learning

MUCH has been said about the adverse effects on the fetus of smoking during pregnancy but so far only the link with low birthweight is well established. Now researchers from the Johns Hopkins University in Maryland have shown that fetuses of pregnant rats exposed to carbon monoxide (CO) show a learning and memory deficit in later life.

CO binds irreversibly with haemoglobin to form carboxyhaemoglobin (HbCO). Charles Mactutus and Laurence Fechter exposed pregnant rats to concentrations of CO of approximately 150 ppm, which produced maternal concentrations of HbCO of about 15·5 per cent. This compares well with HbCO concentrations in human cigarette smokers which ranges from 1 to 16 per cent. A control set of rats received air instead of CO.

They then tested the ability of three male and three female pups in avoiding unpleasant stimuli. The scientists found that 16-day old pups whose mothers were exposed to air were not very good at learning to avoid the aversive stimulus, but that this improved in 30-day old pups. But 30-day old offspring whose mothers were exposed to CO during pregnancy were no better in performing the avoidance task than their 16-day old littermates; moreover they were always less successful at the avoidance task than normal pups of the same age. Although the results cannot be taken to be true for humans, they do support studies which show an impairment in achievement in children whose mothers smoked heavily during pregnancy. □

Gene deletion is not all bad

ON the whole, the loss of two genes encoding essential parts of the haemoglobin molecule can safely be regarded as a bad thing. Most people with such hereditary defects suffer from severe anaemia, especially if the defect is inherited from both parents. But for a few, disaster is averted by the activation of genes that are normally turned off at birth—the so-called fetal globin genes that encode the haemoglobin molecules made before birth, and which are specially adapted to help the baby withstand the oxygen deprivation it may suffer during labour.

This abnormal activation of the fetal globin genes is known as hereditary persistence of fetal haemoglobin, and molecular biologists have for some time been hoping that it might tell them something about how genes are controlled in the course of normal development. With that in mind, Bernard Forget and his colleagues at Yale have been examining two different types of hereditary persistence of fetal haemoglobin to see exactly what is lost with the adult globin genes that might account for the deregulation of the fetal ones (*Proceedings of the US National Academy of Sciences*, vol 80, p 6937).

The genetic defects they were investigating involved only one of the two related families of genes that together provide the protein chains of the haemoglobin molecule. Each molecule is made of four chains, two alpha chains and two beta chains, wrapped round an iron group (the haem group). Each type of chain is encoded by a separate cluster of genes. It was the cluster of genes for the beta chain that Forget and his colleagues were interested in.

It contains four genes, one for embryonic beta globin, which is turned off very early; one for fetal beta globin; and two for the adult form of the beta chain—the two adult forms being designated beta and delta globin genes, and the fetal gene being designated gamma.

In two forms of hereditary anaemia, the complete loss of all the DNA encoding the delta and beta genes gives rise to the persistence of fetal globin production into adulthood. This must mean that along with the adult genes, people with this subtle form of anaemia must also lose the switch that normally turns off the fetal gene. But that switch has proved to be remarkably elusive.

The first place that people suspected it might be found was in the stretch of DNA separating the fetal from the adult genes. But that was ruled out by the discovery of severely anaemic patients who had lost all of that DNA without retaining the use of their fetal genes. So Forget and his colleagues haved turned their attention to the other end of the deletion—down beyond the delta and beta genes.

They had two possibilities in mind: first, that the important thing might be the total length of the deletion—which might distort the structure of the DNA of the entire region, opening up areas that would normally be shut off; and secondly, that the deletion might bring the fetal DNA into juxtaposition with a regulatory sequence, for example an enhancer which normally turns on the delta and beta genes but in their absence turns on the gamma gene instead (*New Scientist*, 12 January, p 21).

What their investigations showed was that the total length of the deletion was remarkably similar in the two different cases, although the endpoints were different. And this might have led them to conclude that it is indeed some general property of DNA structure that is disrupted in these patients—but for the discovery of another group of researchers who have found a deletion of just the same size in a patient not producing fetal globin.

From which they can only conclude that there must be more than one factor involved in the deregulation of the fetal gene: perhaps an enhancer and a suitable DNA structure. Given recent research suggesting an intimate relationship between enhancer sequences and long-range structural properties of DNA, this would not be surprising (*New Scientist*, 17 November, 1983, p 496). And given the heightening interest in these mechanisms, it will also not be surprising if the globin genes soon begin to yield the secret of their regulation. ☐

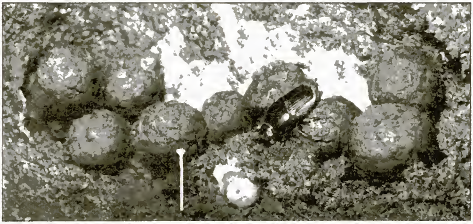
How dung beetles plan families

HOW many eggs should a beetle lay? This becomes an important question for beetles that remain in the nest to guard their brood. Parental care of this type occurs in many dung beetles. These insects have become well known from work in the last century by the French naturalist Fabre, and they have attracted renewed interest because they can remove dung from cattle pastures, for example in Australia and the US.

One such "garbage disposer" is a small scarab beetle, *Oniticellus cinctus*, found in the orient, which feeds on cow dung and hollows out a nest chamber 5 cm in diameter from the interior of the cow pat. Recent work with captive beetles has shown that the female beetle lays about 20 eggs, each enclosed in its own small ball of dung (*Physiological Entomology*, 1983, vol 8, p 393). The female remains in the nest chamber for a month. At the end of this time the brood has completed its development and the new adult beetles emerge. Then, within a week, the mother makes a new nest chamber and repeats the whole cycle. Three or more cycles can be completed by a female beetle in her lifetime. During each month-long brooding period the mother enlarges the dung balls to ensure a sufficient supply of food for the developing larvae, and she attacks other insects that might threaten her brood.

As a gene-machine, the mother's "aim" is to produce as many viable offspring as possible, but to optimise her effort she must limit the number of eggs laid in each cycle. Devoting too many of her resources to egg laying could result in exhaustion and failure to survive the current or future nesting cycles. Laying too many eggs might also mean that she would be unable to look after the brood effectively. In fact, the number of eggs laid, at the start of each cycle is strictly limited, even though the supply of dung surrounding the nest chamber would suffice for very many dung balls. Moreover, the ovary contains more mature eggs prepared for laying than are actually laid in each cycle.

A clue to what is happening is the fact that nesting is reinitiated one week after the previous brood has emerged. The brood itself could be exerting a feedback control to inhibit oviposition. Sure enough, adding extra dung balls (containing eggs or larvae) at an early stage suppressed oviposition, while removing such brood balls from the nest resulted in further eggs being laid. The beetle distinguishes her own eggs and larvae from those of other species, probably on the basis of chemical stimuli. It is likely that similar stimuli from the brood also control oviposition behaviour. This provides a good model of a control that should be widespread in insects showing parental care. In fact there are indications that certain earwigs and plant bugs which care for their brood limit the number of eggs laid. In some social wasps there may also be a stage shortly after founding the nest when oviposition is suppressed in the queen while she is feeding the brood that will give rise to the first batch of workers. ☐



H G Klemperer

Oniticellus cinctus, *a dung beetle, is about to kill the free-living larva of another species (which has entered the nest between the beetle and the 10-mm marker pin)*

If your home uses gas — and the chances are it will, since British Gas is the largest single supplier of heat in Britain — then you are benefiting from yesterday's planning and investment in advanced technology by the gas people.

Yesterday's research anticipated the needs of today's customers, and some of the developments produced by the gas people were revolutionary.

Did you know, for instance, that the gas people helped to pioneer the technology for transporting gas across the world's oceans — gas which would otherwise be wastefully flared-off? This was done by cooling the gas into liquid form at minus 160°C and carrying it in specially designed tankers. The transportation of LNG is now a major world trade.

The gas people also saw opportunities in newly available gas-making feedstocks and developed the Catalytic Rich Gas process for making gas from oil, rather than coal. Advances like these underpinned the transformation of an ageing industry into a highly competitive and rapidly expanding modern business.

The gas people went on to exploit the natural gas which they had helped to discover around our shores. To achieve this they constructed a network of underground high pressure steel pipelines to the highest standards. A great deal of money and technical expertise were expended in devising a means of inspecting these pipelines, and a sophisticated electronic and mechanical device called an 'intelligent pig' was developed. It works inside the pipeline while the gas is still flowing.

TOMORROW'S WORLD

Yesterday, the gas people solved what would have been today's problems, and we've given you just a few examples. But you may be more interested in the work we're doing today to solve tomorrow's.

For instance, in readiness for the time when Britain's indigenous supplies of natural gas begin to decline, and nobody knows when that will be, the gas people have already developed the technology for producing substitute natural gas from coal. The results of this pioneering work are being viewed with great interest in many parts of the world. Whichever feedstock is available at a competitive price, however, the gas people intend to have the technology to produce a substitute natural gas from it.

And because gas will still be there for tomorrow's customers, the gas people are helping to develop a new generation of appliances for tomorrow's low-energy homes. They are starting to apply ways of recuperating waste heat in industrial and commercial applications by using gas engine-driven heat pumps. These reverse the normal process by which heat flows from a high temperature to a lower and so can consume less energy than they deliver! The gas people are even looking at new ways to avoid traffic congestion — by replacing underground gas pipes without the need for digging up the road!

Much more is going on besides, so if you'd like to find out about today's high-tech gas industry, write to the Public Relations Department, British Gas, Rivermill House, 152 Grosvenor Road, London SW1V 3JL.

Gas

WONDERFUEL GAS FROM THE GAS PEOPLE - WORKING FOR TOMORROW'S WORLD TODAY

TECHNOLOGY

University satellite is en route to NASA

Helen Gavaghan

UOSAT B, an experimental scientific and educational satellite, designed and built at the University of Surrey, is shipped to the US today (Thursday). If all goes well, it will be launched by NASA at about 18.00 hrs on 1 March. Once launched the satellite will be known as Uosat 2, and it will join its sister satellite Uosat 1, launched in September, 1981.

The electronics engineers responsible for Uosat 1 wanted to build a second craft to reflect what they had learnt from their first foray into the satellite world.

Their chance came when NASA offered to launch Uosat B—free of charge—on 1 March this year. The offer was made last September, which left engineers only five months to design and build the satellite. To meet the deadline, a team, led by Dr Martin Sweeting, has worked round the clock. Last Friday, the craft was moved to the Rutherford Appleton laboratory for vibration and thermal testing, and then packed for its trip to the US.

When Uosat is launched it will be as the secondary payload on a Delta 3920 rocket—Landsat D is the primary load. Uosat B's planned orbit is 700 kilometres high, and the satellite will be overhead at the same time of day throughout the year (polar and Sun synchronous orbit). It is expected to work for three years, and will be controlled from the university.

Uosat B weighs 60 kilograms, is smaller than its sister craft and most of its electronic circuits differ from Uosat 1. But, like Uosat 1, it will carry scientific and engineering experiments, which professional scientists, radio buffs and schools will be able to take advantage of.

Also, like Uosat 1, it will carry a computerised voice synthesiser, although its vocabulary is four times greater than the 150 words Uosat 1 can manage. The satellite will send some "spoken" information back to earth about the experiments on board.

There are six experiments—five relate to science and education and one will look at spacecraft systems. The science and education experiments are: earth imaging; synthesised speech; digital communication; and data collection on particles and space dust.

The University of Surrey devised the synthesised speech and space imaging experiments. It will be possible for the pictures taken by Uosat B to be decoded and stored on simple equipment and displayed on a television. Uosat B's camera will view an area 1600 kilometres square and distinguish objects as little as 2 kilometres apart.

Three Geiger counters and one electron spectrometer will look at the behaviour of electrons in the magnetosphere. This is where the behaviour of charged particles is dominated by the Earth's magnetic field. And the satellite's camera will help out with this experiment by taking pictures of auroral displays around the polar regions.

University of Surrey

Uosat A, before being launched. Its new sister craft is slightly smaller but similiar in appearance

The digital communications experiment is being devised by the US and Canadian branches of the Amateur Satellite Corporation (Amsat). It is an extension of studies already underway on Uosat 1. The aim is to find a way for an amateur radio station to send information via a spacecraft to another station at the other side of the world. The message should be stored until it is ready to be received by the second station. The problem with this experiment is the lack of knowledge about the reliability of solid state memory devices in space.

Uosat B will carry various types of static and dynamic memory devices. Their long term performance in space will be assessed.

The fifth scientific experiment belongs to the University of Kent in England. It will use sensors developed for the European Space Agency's mission to Halley's comet. The sensors will detect and measure the momentum of cosmic dust particles and debris from rockets.

The spacecraft-system experiment is another one devised by the University of Surrey. Uosat B will carry instruments which should help the university command team to control the satellite more easily than Uosat 1. The control should also be more accurate—within plus or minus 2 degrees.

Uosat B will cost "nearly £½ million" to build; it is being paid for by the university and industry, although negotiations between academia and commerce are not yet complete. □

Gregorian chant crosses the Atlantic

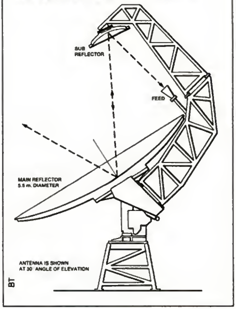
BRITISH Telecom has developed a roof-top aerial to overcome the problems of communicating with satellites positioned close together in space. There could soon be another 60 satellites in geostationary orbits around the equator. For them all to fit in, the distance between them must become shorter—and this means having antennas on Earth stations capable of producing narrower microwave beams to avoid interference.

Engineers from British Telecom International (BTI) installed the first of the new dishes on a roof top in Ealing, West London, at the end of last year. It forms part of SatStream—BTI's digital transatlantic satellite link set up with Teleglobe Canada. The first customers will begin using the link by the end of this month.

To produce a narrower beam, BTI has introduced a 5·5-metre dish called an offset Gregorian antenna. The dish is shallower than the current Cassegrain reflector antenna, and the sub-reflector and feed are to one side of the dish rather than in the centre.

This means that less power is blocked by the sub-reflector's supporting structure. Because of this a narrower beam than used in the Cassegrain reflector can concentrate the same amount of power as a wider beam from the same diameter dish in the Cassegrain design. Since the beam is narrow it will not spread out enough to interfere with neighbouring satellites. Engineers can achieve the same results using traditional reflector designs, but only if the dish has a diameter greater than 8m—too large for many business users. □

British Telecom International's new small-dish earth station for SatStream business communications services to North America



SUB REFLECTOR
FEED
MAIN REFLECTOR 5.5 m. DIAMETER
ANTENNA IS SHOWN AT 30° ANGLE OF ELEVATION

BT

Computer firms battle for hearts and minds

Ian Anderson, San Francisco

A PERSONAL computer revolution is erupting on college campuses across the United States. Fundamental changes are coming in the way classes are taught, research is done, and universities are adminstered. Also a fierce battle is brewing between the nation's leading microcomputer manufacturers—in particular IBM, Apple and Digital—to capture the lucrative higher education market, and win the prestige that goes with having their products used by the top universities.

WE SHOULD HAVE FORESEEN THIS
PEYTON

Soon, all staff and students at many colleges will either have their own micros or ready access to one. These computers will be offered at staggering discounts of up to 60 per cent. Some will be bought at the computer stores that are springing up on the college campuses, including Harvard and Dartmouth. Already four universities have decided that all new students must buy their own computers as a requirement of admission. They will be paid for by instalments which are added to term tuition fees.

Other universities are talking about being miniature "wired cities" linked to local communities where learning and day-to-day activities such as shopping and banking will be conducted electronically.

Carnegie-Mellon University in Pittsburgh, for example, boasts that it will be a computer community by 1986 and that its network of 7500 personal computers will outnumber the students. At all times information will be at the fingertips of students. No need to queue to register for courses or to borrow that much-needed reference that everybody else wants—it will be available on the monitor at their home or dormitory. The university is also working with Warner Communications, holders of the city's cable TV franchise, and Bell Telephone to extend the communications links into the community.

Brown University in Rhode Island and Stanford University in California are also well advanced with planning for a wired city. Brown already has a broad-band cable system that will become the basis of its network. Stanford is establishing a network called SUNet that will link all computer terminals on campus and allow the transmission of digital data and video images.

Few oppose what is happening. "The technology is here to stay," one senior Stanford administrator said last week. "We need to be part of it." There are many bonuses. Courses, especially languages can be taught by computer. Bright students who are specialising in either the humanities or the sciences can learn other disciplines. Individual professors, providing they can program, can be responsible for a lot more courses. Those universities struggling for enrolments can diversify and offer mature students courses by computer.

But even those who are committed to the computer revolution caution against going too far too quickly and losing some of the values of traditional education.

"We need our charismatic lecturers," said Professor Patrick Suppes, a philosopher at Stanford who has the rare distinction of being admitted to the National Academy of Sciences. Suppes, whose course on logic has become a model for computer instruction, admits that there is a danger of making learning too impersonal. Also, too often courses given on computer do not go through the rigorous editing and evaluation that is part of the best textbooks. Another big problem, says Suppes, is the lack of adequate curriculum materials, which will require huge investments in capital and resources to develop.

Others worry that many universities will be left behind. It is no coincidence that the universities being courted by the industry are the cream of the country's public and private colleges. "It could be a case of the rich getting richer," said Paul Kaufman from Stanford's Center for Information Technology, adding that many state-run colleges had limited computer facilities. Henry Levin, education professor at Stanford whose research has shown that technology will not provide the number of jobs that many people predict, says there is also a danger of universities becoming captives of one manufacturer. "You may be committed to the wrong computer infrastructure." said Levin.

But being captive to a company is precisely what the battle being waged by the industry is all about, although altruistic motives such as improving America's foundering technical education are also mentioned by spokesmen. The potential market is estimated to be $8 billion a year—much higher than the current sales of $1·3 billion. Stanford alone spends $750 000 a month on academic and administrative computers.

In the last few days Apple, IBM and Digital have announced extraordinary deals involving universities. Other companies are also involved. For example, Hewlett-Packard expects to grant universities $30 million in equipment this year. And Zenith Corporation, against stiff opposition, was awarded a contract to supply every one of the 3800 undergraduates at Clarkson College of Technology in New York with a computer by 1986. But the main players are the big three.

Apple has formed the Macintosh Consortium, through which 24 universities will receive the company's new and highly-acclaimed computer for about $1000—its retail price is $2495. Dartmouth, Drexel and Michigan have already agreed to buy 6000 machines over the next three years. On 3 April Stanford will launch a new plan that will allow students and staff to buy Macintosh and other makes of computer at substantially lower prices.

The universities in the consortium will develop courseware and educational software for the Macintosh, which they are expected to share among themselves. But they may also market the material and reap the financial returns. The benefit to Apple is that it will increase the amount of software available for its products.

Apple has no pretensions about what it is doing. It wants to get students into the habit of using its products.

IBM is more circumspect. Its philosophy, according to a spokesman, is "to advance the educational system in the US as well as improve computer literacy". But no doubt it also has an eye on Digital Equipment Corporation, which has bettered IBM in the academic market in recent years.

IBM is pouring $70 million into grants and donations to universities. It is also training teachers and loaning staff to universities for computer design courses. At the University of California—Berkeley last month IBM announced a grant of $10 million worth of equipment and technical support for the university to install over the next three years a network of about 800 work stations linked to a central computing facility. A similar programme is going ahead in Europe.

Digital's line is that it has been with universities for many years and the others are Johnny-come-latelys. It has just announced a subsidy of $16 million to 14 universities so that they can use its products to develop courses and research in disciplines not heavily involved with computers. Later this month an $8 million deal with the University of Pittsburgh will be announced which includes a new networking system. Digital has also supported artificial intelligence work at Stanford and Carnegie-Mellon. One of its main reasons for supporting universities is to help it recruit its own staff. □

Lasers can simplify chip manufacture

Paul Breeze

LASERS could soon be simplifying the manufacture of microchips if a technique developed by physicists from Lawrence Livermore National Laboratory at the University of California proves successful. The new technique could do away with much of the paraphernalia of microchip manufacture such as masks and light sensitive materials.

The raw material for most microchips is a thin wafer cut from a perfect crystal of silicon. This is fashioned into an electric circuit by doping some parts of the wafer to make it conduct electricity and electrically insulating other parts. Finally, all the different parts of the microchip are connected by metal.

During each of these processes the silicon wafer is coated with a light sensitive material called a resist. The areas to be treated (that is—doped, insulated or connected by metal links) are exposed to light through a mask that blanks off the rest of the silicon. The exposed resist is etched away, often with corrosive chemicals, to reveal the underlying semiconductor. Then the appropriate process is carried out on the exposed material whilst the rest is protected by intact resist.

A complex microchip may require seven or more processing steps. Each needs a different mask that must align precisely with all the previous masks. Furthermore, during each step, the wafer passes through wet and dry stages, making handling complicated. It would be simpler if the whole process could be carried out in one environment—preferably dry.

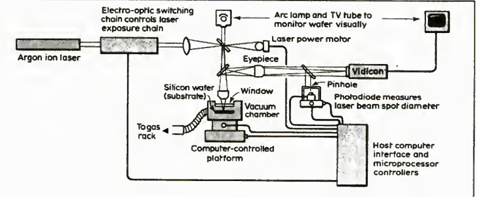
The scheme developed at Lawrence Livermore achieves just that. Every step is performed in the same chamber, in a dry gaseous environment.

The key to the process is the ability to make all the parts of a microchip with a laser which can generate elements as small as 1 micrometre across—small enough for today's microchips. Because the laser beam is finely focused there is no need to use masks or resists to protect parts of the silicon that are not being worked on.

The process starts with a wafer of silicon coated with a thin insulating layer of silicon dioxide (glass). The wafer is placed on a special platform in a vacuum chamber, and the laser is focused on the centre of the wafer. Intensity of the laser beam and exposure time are controlled by a microcomputer. This also controls the wafer's position by rotating the platform or moving it in any direction in half-micrometre steps.

The team needs four processes to make a transistor. In the first stage a gaseous derivative of silicon is allowed into the vacuum chamber. As the gas comes into contact with the area of the wafer where the laser is focused it decomposes, leaving behind a layer of silicon. With the addition of a little phosphine, phosphorus can be included in the silicon as a dopant (dopants affect electrical conductivity).

The second step removes tiny areas of the silicon dioxide layer to expose the silicon beneath. One approach is to let the laser alone heat the oxide over a small area and vapourise it. However, if a mixture of hydrogen chloride and hydrogen gas is allowed into the chamber, the etching proceeds more rapidly than without the gasses, and with lower laser power.


Electro-optic switching chain controls laser exposure chain
Arc lamp and TV tube to monitor wafer visually
Laser power motor
Argon ion laser
Eyepiece
Vidicon
Pinhole
Silicon wafer (substrate)
Window
Photodiode measures laser beam spot diameter
Vacuum chamber
To gas rack
Computer-controlled platform
Host computer interface and microprocessor controllers

Chip manufacture can take place in a dry environment in a vacuum chamber

The exposed silicon now needs to be doped. Again phosphine is admitted into the vacuum chamber, where it decomposes in the laser beam, leaving a layer of phosphorus on the surface of the semiconductor. Using the power of the laser, a small volume of the material is melted and at the same time phosphorus is driven into the silicon wafer.

Finally, metal interconnections must be made. If a mixture of gaseous compounds—tungsten hexafluoride and hydrogen—are fed into the chamber, a laser will make the two react to deposit tungsten metal. By moving the wafer under the laser spot, metallic tracks are produced.

Using these four procedures the physicists at Lawrence Livermore have demonstrated, for the first time, that direct laser writing alone is capable of producing transistors and more complex circuits. The team is now working on a system to produce one thousand circuit elements per second. If they are successful, they will have provided a greatly needed simplification to the process of making microchips. ☐

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Sheffield looks for cheap energy

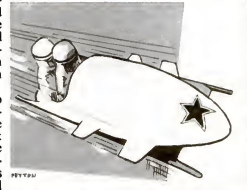
SHEFFIELD City Council is to go ahead with a study that will take it one step closer to the production of combined generation of heat and power. The European Commission is contributing £300 000 to the work to be carried out by consulting engineers W. S. Atkins and partners.

The scheme to be studied is based on a coal gasification plant which will produce synthetic natural gas from coal for use as a fuel in power generation. British Gas, which developed the process, believes coal gasification is approaching commercial viability. Combined generation of electricity and heat is a way of using fuel more efficiently than when electricity only is produced. Although the amount of electricity generated goes down for a given amount of fuel, heat can be produced for district heating schemes.

Sheffield is one of nine cities selected by the government as a potential site for a city-wide combined heat and power scheme. It is also the city most keen on the technology. Should the scheme prove cheap enough to carry out, the city will have a buyer for some of the electricity it generates. The South Yorkshire transport authority is thinking of reintroducing trams which would run on a light rail or catenary system. And, of course, the Yorkshire Electricity Board would be obliged by last year's energy act to buy any excess electricity. ☐

Russian bobsleigh heading for medals

THANKS to a £½ million investment and training the Soviet Union looks set to win medals in the bobsleighing events at the Winter Olympics. Tomorrow and Saturday will see their much-vaunted aerodynamic bobsleigh take to the run for the two-man event.



It is designed to meet the requirements of the rule book—just, and at 600 millimetres wide has the smallest frontal area allowed. Its speed is also helped by the aerodynamic wings at either side of the sleigh. But the most important aspect of the Soviet sleigh is its power-to-weight ratio. The sleigh is made of lightweight materials and driven by highly trained athletes who can supply the power for a fast start. At the end of the race the sleigh plus drivers must not weigh more than 350 kilograms, and again the Russians will hope to be just inside the rules. It was this rule that the Soviet team transgressed in the four-man bobsleigh event at the European championships.

By contrast, the British team will be sending its number one driver out in an off-the-shelf Italian sleigh, though the number two in the team will drive a sleigh specially designed by Ian Jones—an engineering consultant who used to work for Lotus. Jones's sleigh is steered like a car whereas all other designs have centre-pin steering. It also has suspension at each of the four corners. Said Jones, "One of the first rules of the game is that you get better control if you keep all contact points moving together." Better control means that speed is not lost by banging against the walls at the beginning of the run. And Jones believes that his design should give the British an advantage during the first 400 metres.

Unfortunately the bobsleigh Jones sold to the British Olympics team was damaged in practice and Jones cannot afford to fly out and repair it. "I made £400 on the £3500 sale, neither I nor the sport gets any backing from Britain. I cannot go around Europe as a mechanic giving free service." ☐

Secrecy order

THE MINISTRY OF DEFENCE and Patent Office have slapped a secrecy order on an invention made by a small firm which makes computer tapes, in Barnsley, South Yorkshire. This means the firm—JLC Data—and the inventor Jim Lamont, cannot talk about what they have done. But the latest issue of *Personal Computer News* (February 4) tells part of the story.

Lamont claims to have invented a system which prevents people copying computer programs, from one cassette tape to another. A coded imprint on the master tape appears, as if by magic, when a copy is made and spoils it.

The government obviously thinks the JLC idea is worth a close look. Under British law the Patent Office must notify the appropriate secretary of state if it thinks that any new patent application contains an idea that is prejudicial to "defence of the realm" or "safety of the public". If the Government, usually the MoD, agrees with this appraisal, then the case is deemed secret and locked away from public view. In some cases it is never published. The inventor then gets compensation. If the MoD now maintains the secrecy order on JLC's invention it will be preventing the British computer software industry from using a system to prevent commercial piracy. If the MoD lifts the order it is tantamount to saying that the idea is not as good as the inventor believes and that even the Patent Office was fooled. ☐

Guinea-pig town tests technology

MILTON KEYNES is a town acting as a guinea-pig for technology and design ideas aimed at making homes more efficient and comfortable in the future.

Local architects are finishing off a report to the Department of the Environment on fuel consumption monitored in 200 carefully designed homes, since 1981. These have double glazing, and wider wall cavities and better loft insulation than is specified for homes being built now. But the main break with tradition is that most of their windows face south. The report will show that an investment of £600 can cut gas bills in half.

Because of this success, work begins this summer on a 150-hectare energy park where homes, factories and offices will all be built with south-facing glazing so that they collect and store their own solar energy. Wind losses will be cut by strategic hedgerows. In the long term Milton Keynes plans a heat main to supply all buildings in the park with hot water from a central generator plant.

But dependence on an unproven heat-main system could leave everyone cold if it broke down. So the park will initially use a clutch of small-scale systems. These rely on modified car engines run on natural gas, which supply hot water and electricity to 40 or 50 houses at a time. With an optimistic eye to the future, the architects are leaving room for a full-size heat main to serve the whole park, if and when the small systems prove reliable.

The town is also at the forefront of Cable TV. All homes are already wired for limited cable TV and radio service. Unfortunately, Milton Keynes was not granted one of the first 11 franchises for a pilot service, and the town's planners admit to being "shattered" by the Home Office's decision.

Already 24 000 homes pay £16 a year to British Telecom and cable company SelecTV for off-air radio and TV to be piped into their homes. Of these homes only 1600 pay an extra £10 a month to receive a feature film service as well.

Although the Home Office said no to a full-blown 30 channel service in Milton Keynes it gave the go ahead for SelecTV to supply four extra channels as soon as it likes.

Other firms in the business of cabling British cities are watching avidly to see how much SelecTV dare charge for this service and how many people will pay for it. If cable fails in Milton Keynes, it is unlikely to succeed anywhere in Britain. There is no public cinema and the main entertainment is watching TV at home.

But, if the people would rather play with home computers than watch TV they can always go along to Milton Keynes's Information Technology Exchange (ITE) for a £50 course. The Development Corporation is providing £300 000 over three years to ITE and the DTI is contributing £26 000. But there are not nearly enough customers to make the exchange self-supporting and it may have to try and make ends meet by selling computers, or computer services, when the grants run out. One of the most popular courses so far was for local parents who wanted to try and understand what their computer buff children were talking about. ☐

Food or TV

ETHIOPIA, one of the world's poorest countries, is to launch a colour television service this year. The government has awarded a contract worth £3·5 million to a British company, Crow, to set up television and radio broadcasting stations.

British engineers will re-equip Addis Ababa's television studios for colour, and train Ethiopian technicians. The contract also covers the supply of two outside broadcast vehicles with electronic news-gathering equipment.

The Ethiopian government hopes to have the colour television service operational by September, the tenth anniversary of the overthrow of Emperor Haile Selassie. According to Crow, the contract will "provide the Ethiopian people with colour TV broadcasting on the national network".

In fact, few Ethiopians will benefit. According to official figures, there are about 27 000 television sets in the country (population nearly 35 million), and with an average income of $130 a year, few people can afford colour sets.

Social conditions are another obstacle to most Ethiopians ever enjoying *Dallas*. Despite the revolutionary government's health programme, the average life expectancy in Ethiopia is 39 years. The latest figure for infant mortality is 172 per 1000 live births. And in the drought-stricken north of the country, people lucky enough to receive aid live on 250 grams of grain per family per day. ☐

Jerry Mason

Teamwork at the University of Sheffield. The university has set up a specialist biotechnology company with money from 3i

Biotechnology demands a special strategy

British biotechnology needs a new partnership between government and industry, especially to keep the development of process plant, enzymes and vaccines

Ronald Colman

I HAVE NO DOUBT that biotechnology will have a significant commercial impact during this decade; by the year 2000 it may well result in annual production worth tens of billions of pounds worldwide. Already, many new biotechnology-based companies have been formed worldwide, with share values exceeding one billion pounds because biotechnology has potential application in many diverse activities, such as health care, agriculture, environmental control and energy supplies. It is inevitable that resources on this scale will result in the development of new products and markets; and it is important that the UK achieves a significant share of world markets to come. I believe this aim is most likely to be achieved if we have a coordinated national programme for biotechnology which meets the needs of government and industry.

A national programme can take many forms. In my view, an essential ingredient is that the climate in the private sector must be as favourable as possible for both innovation and the development of new products. It should be supported by the most effective use of available funds, the sharing of which must be decided with the help of the best information available from a wide range of sources. A successful programme must maintain the country's strengths and build up vital areas to a level at least comparable with our overseas competitors.

A key feature of the initiative from the Department of Trade and Industry (DTI) launched by Patrick Jenkin in November 1981 was the formation of a Biotechnology Unit, with experienced staff seconded from industry, to advise on the allocation of resources. More recently a new consultative committee, chaired by a minister of state, Kenneth Baker, and composed mainly of senior industrialists with a few government officials, has been formed. The committee will ensure that government support and policies take account of industrial needs and opportunities.

Successful development of biotechnology in the UK must involve an effective partnership betweeen the public and private sectors. The basic research supported by research councils should be encouraged, not so much to develop products but to provide the scientific understanding of cell mechanisms of different species and biosynthetic routes for protein production and control. A programme of this nature cannot be entirely centrally planned as it depends on initiatives and proposals from many individual research workers. Nevertheless, it is desirable (as spelt out by the SERC) to identify strategically important areas and to encourage relevant proposals for them. The areas identified by the SERC, after consultations with industry, include immobilised enzymes and cells, plant genetics and biochemistry, the large-scale growth of mammalian and plant cells, fermentation technology and microbial physiology, new reactor design and concepts in downstream processing, and sensors and bioelectronics.

In my view it would be beneficial if the other research councils identified a similar set of strategically important areas for study. It is important that industrial researchers interact more effectively with academic laboratories so that developments and advances are transferred rapidly. This is likely to be best achieved by a close working relationship in joint projects. These may be in the form of club activities; for example, the Leicester Biocentre programme in yeast genetics involving John Brown Engineering and Constructors, Dalgety Spillers, Distillers, Gallahers, and Whitbreads, or the Institute of Biotechnological Studies project on immobilised biocatalysts involving companies such as Glaxo, May Baker, Shell and Unilever.

Support for the public sector

Alternatively, collaborative programmes sponsored by SERC or DTI, which jointly fund links between individual companies and university groups to meet specific objectives, can also be very effective. The other research councils should seriously consider partial support of applied research by collaborative methods to improve the academic links with the medical, food and agricultural industries.

Companies and universities will be helped to make links by the Biotechnology Unit's *Directory of British Biotechnology*. It will provide a detailed account of British companies and academic groups active in this field. Publication of the directory is planned for March 1984.

The DTI has a significant programme of R&D support for public sector laboratories, including Warren Spring Laboratory, Harwell and CAMR Porton. The aim is to encourage pre-competitive research in collaboration with companies, particularly in the area of fermenter design and the development of downstream processing plant. These laboratories also have pilot plant facilities which can produce limited quantities of specific products for the evaluation of their departmental programme to encourage all parts of the biotechnology process, from genetic engineering through to product purification.

In November 1982, the DTI launched a three-year £16-million programme to help the development of British biotechnology. The DTI actively supports and encourages biotechnology within companies. First of all, through assistance with consultancy studies, enabling companies to evaluate opportunities and threats to their existing business. Secondly, by supporting the research and development of processing methods. The supported projects cover a very wide range. They include the large-scale production of monoclonal antibodies at Celltech, polyhydroxybutyric acid development at ICI and the development of anaerobic digestion processes for food and distillery wastes. The Biotechnology Unit, which manages the support scheme for biotechnology, is evolving a series of strategic studies to ensure that support to industry makes an international impact.

It is already clear that there is a key opportunity for British companies in building the process plant required for biotechnology. A detailed evaluation of the plant available from British and foreign companies is in progress. Plant requirements for the future are also being studied. This study should help to pinpoint specific opportunities for equipment manufacturers as well as longer-term R&D requirements.

The application of enzymes in biotechnology processes is expected to increase substantially, and it is important that Britain strengthens its position in this area. Support for R&D alone, although important, is not likely to allow British companies to compete effectively with Novo and Gist Brocade (except in limited sections of the market). Effective collaboration between users and suppliers of enzymes seems to be prerequisite to gaining a greater market share.

Ronald Colman: Britain will only gain its share of biotechnology markets by a "coordinated national programme which meets the needs of government and industry"

In the past, the production of vaccines has been the Cinderella of the pharmaceutical industry because of their relatively low profitability. It is not surprising that companies have tended to devote resources to pharmaceuticals with high added value. Developments in genetic engineering offer many new opportunities for preventive medicine. It is therefore important to maintain a satisfactory position in vaccines; R&D in new vaccines for human and animal care deserves increased support by the public sector. It is expected that a few additional priority areas will emerge over the coming months. Industry will be encouraged to evaluate these carefully. Equally important is that the Biotechnology Unit has identified some applications which do not seem to be worthwhile for Britain. They include biomass conversion for the production of bulk chemicals and power alcohol to replace fossil fuel feedstocks.

In the four years since the publication of the Spinks Report, attitudes towards biotechnology have changed considerably.

Jerry Mason

Should the research councils identify strategic areas of study?

The elements of a possible boom

HOW DOES Britain compare with other countries in biotechnology? First, though probably not the most important point, the total public funds available for biotechnology in the UK is of the same order as that available in Japan, West Germany and France and considerably more than other European competitors. It is significantly less than the money available for basic research in the US.

Public funds for R&D worldwide

	Biotechnology R&D £m	*Biotechnoloy relevant R&D £m*
West Germany	21	75
France	18	48
Britain	26	34
Italy	7	20
Netherlands	6	15
Belgium	5	8
USA	135	360
Japan	35	?

Source: EEC, figures are estimates

Britain's basic research in biochemistry, fermentation, molecular biology and other technologies important to the application of biotechnology, is highly regarded internationally; the resources devoted to these areas is second only to those of the US. There is a good basic research base which is well supported by the research councils as a matter of priority. In the case of the Science and Engineering Research Council (SERC), all its budget is spent in the universities and polytechnics. The Medical Research Council (MRC) and the Agriculture and Food Research Council (AFRC) spend the majority of their cash in their own institutes.

The education and training facilities in the UK, available or planned, can ensure an adequate supply of trained manpower, both for R&D and, ultimately, for production. We expect to meet the targets for trained biotechnologists recommended by the Royal Society. The SERC in particular has encouraged the development of MSc courses in biotechnology (courses have doubled to four in the past two years) and it has increased its support for PhD students (now 32 per year). There are some specific shortages: for example, few biochemists have expertise in plant biochemistry, which is important to the development of biotechnology for the benefit of food and agriculture. It would be desirable if the AFRC increased its support to universities with good research proposals in plant biochemistry, as this would then feed back into the education process.

The infrastructure supporting biotechnology in the UK is well developed. The legal framework which controls health and safety at work, pollution, product manufacture and sale, is perceived by industry to be balanced and sensible, without restraining the development of product and processes, and to protect workers and the public. The fact that Eli Lilly chose the UK to produce human insulin, and G. D. Searle built its £7 million pilot plant to develop products based on recombinant DNA, show that enforcement is realistic and not unnecessarily restricting.

One feature of the economic climate outside the control of the British government, but which limits development to some extent, is the protection of agriculture by the European Economic Community. High fructose syrup produced from starch by immobilised enzymes is an important sweetener in the US, but the tariff imposed by the EEC to protect sugar growers has seriously limited its manufacturers in Europe. Additionally, this has affected the development of large-scale immobilised enzymes processes in general. Further, unless action is taken to bring the community price for starch and sugar into line with world prices, then some production plants, for citric and lactic acids for example, will go overseas, inhibiting further process development in biotechnology. Fortunately, the European Commission has realised the disincentive of inflated raw material costs, and proposals to rectify the position with respect to biotechnology are under discussion.

The fiscal regime for R&D in Britain is as favourable as for most developed countries. R&D revenue and capital expenditure can be written off for tax purposes in the year in which they are consumed. However, some improvement in the tax liability for gains on share options for employees of R&D companies and the inclusion of such companies in the Business Expansion Scheme would encourage new companies and the retention of key employees. While the successful development of biotechnology does not depend necessarily on small genetic engineering companies, in my view the intense competition from the large number formed in the US is likely to lead to many new commercial opportunities. A few American firms will grow into major producers in the next decade. In the past three years, more of these companies have been formed in Britain than elsewhere in Europe but, so far, not on the same scale as in the US.

Finance is available from the City in return for an equity stake in such companies but the general view of UK venture capital sources is that there have been too few well-researched opportunities with clearly identified products presented to them. Thus, most of the funds available from Rothschilds Biotechnology Investments have been placed in the US because scientists there have pooled resources with entrepreneurs able to prepare business plans and well-written prospectuses. However, 3i, part of the Finance for Industry group, has been more successful because of its policy to seek opportunities in the universities and to help with the preparation of the business plan and the management of the new company.

DTI support for biotechnology

Sector	*Commitment £m**
Pharmaceutical products	1·4
Diagnostics	1·1
Monoclonal antibodies	0·4
Enzymes	0·1
Specialty chemicals	0·3
Food/Agriculture	1·5
Bioelectronics	0·4
Waste treatment	0·6
Process plant	2·0
Bioreactors and Fermenters	3·0
Plant and animal cell production	0·7
Culture collections	0·7
	£12·2

* Funds committed by DTI since June 1982, not including industrial contributions to projects

Imperial Biotechnology and Plant Sciences are two such new companies exploiting specific market opportunities. They have arisen from Imperial College and Sheffield University respectively. It is important not to overemphasise the role of small companies. The performance of the pharmaceutical and chemical companies in Britain has, in general, been good compared with those in most other countries.

Thus, Britain has a good industrial base to take developments in health care and speciality chemical products into the market place. Further, Britain is a major centre for chemical contractors who will be able to absorb extra production. Individual companies, such as John Brown Engineering and Constructors which, in conjunction with ICI, built a large fermenter to produce single cell protein, have clearly demonstrated their capabilities in sterile engineering for biochemical products. ☐

There is a general awareness that this technology will have major industrial significance in the medium and longer term and that resources devoted in Britain to its development, both public and private, are fully justified. There is no room for complacency and much needs to be done in the next few years to strengthen the British position, particularly by the industry itself. Biotechnology is an international business; to succeed in it Britain must aim for significant shares in specific markets. In most cases it will be impossible to protect the home market unless we are internationally competitive.

The major chemical, agri-food and pharmaceutical companies have well-developed plans to exploit biotechnology as profitable market opportunities appear. They can be most effectively helped by building up our science base in strategically important areas. For the smaller and medium-size companies, as well as the specialist biotechnology firms, continued public support for R&D will be required for some time. Above all, we must ensure an effective partnership of public and private sectors so that government support and policies can provide the sound foundation that companies need to plan effectively for the future. ☐

Ronald Colman is the Government Chemist with responsibility for sponsoring the application of biotechnology in industry.

Industry wants a role for government

The biotechnology industry does not want to gamble its future just on market forces. It wants the government to set out a national development programme

Stephanie Yanchinski

INITIAL REACTIONS from biotechnology companies favour the suggestion that the government should take an active role in the industry's future. The proposal has been made by Ronald Colman, the Government Chemist who is also responsible for the industrial development of biotechnology. *New Scientist* spoke to Edward Dart, head of ICI's corporate bioscience and colloids laboratory, Gerard Fairtlough, chief executive of Celltech, and Caroline Vaughan, its director of business development. ICI's views are rather different in detail to those of the much smaller Celltech, but everyone agrees that the industry cannot afford to gamble its future solely on market forces or scientific objectives.

Edward Dart, one of the architects of ICI's own biotechnology strategy, says that "the government urgently needs to set priorities, not for industry but for research". He adds: "If we don't get the research right we will fall behind. In order to compete in the real world, we have to believe we can bring something special to the underpinning science."

He warns that burgeoning commercial offshoots from British universities could divert scarce resources away from research. "Universities should not try to do industry's job. They are there, in part, to provide the basic science on which British industry depends. Academics believe they have a good picture of what industry needs but their commercial judgements are often naive."

So the question remains of how to set these research priorities. Dart: "I'd start not by focusing on what technology can give us but by first deciding which UK businesses will prosper through using biotechnology to radically alter their product approach." He names three industries, with a proven track record in exploiting new technologies, that especially deserve attention: pharmaceuticals, agriculture and food. They should target those sections of the market where biotechnology does not compete with conventional chemical synthesis. The new immune regulators, treatments for cancer and arthritis, new plant varieties which give rise to microbially-based pesticides and even agrochemicals, and new additives for food can give the large returns, necessary for the budding biotechnology industry.

Celltech's Vaughan: Government guidance on purchasing policy "is easy to lay down but difficult to carry out . . . The NHS is cagey about trying anything that is new"

Jerry Mason

Gerard Fairtlough: "It would be a good thing to have a dozen Celltechs. We are a bit of an oddity . . . people would feel more comfortable dealing with us"

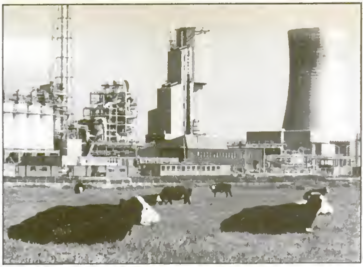
Unlike Colman, however, Dart does not believe it is commercially worthwhile to develop new enzymes, despite the predictions of a market worth hundreds of millions of dollars. "How many new enzymes are going to be developed?" he asks. "I don't believe there will be any dramatic new business here."

Dart wants commercial effort to be backed by more basic research in areas such as plant physiology and biochemistry, "receptor" biology for designing new drugs, and human immunology and toxicology. The latter could benefit biotechnology indirectly by lessening the need for expensive animal testing of drugs and so freeing more money for R&D. He thinks the Agricultural and Food Research Council and the Medical Research Council have been slow to tackle research that could help industry compete internationally. "A way must be found of opening up the debate with the AFRC and MRC."

Dart cites threats to the British biotechnology industry which arise either out of the government's cuts in science or its non-interventionist policies. For example, proposed cuts in the research budget of the Science and Engineering Research Council (SERC) may reduce its flexibility to fund projects as the need arises; process engineering, crucial to the exploitation of biotechnology innovations, could suffer in particular. The brain drain is another source of concern, says Dart; many ascribe the problem to the uncertainty facing Britain's universities. Liaisons with Japanese companies and American investment in Britain, encouraged by the government's free trade policy, could "siphon off good ideas".

Lastly, Dart thinks that the government should not encourage the growth of more small companies financed by venture capital. "The Americans can afford the shotgun approach and the Japanese culture allows the government to plan exactly what it wants to do. The UK doesn't have the cash or the culture to follow either of these tracks. We must get our edge in other ways." Dart suggests that research councils should catalyse partnerships between universities and industry, with industry being more open in defining its science needs and universities using research council money to help satisfy them.

For small, but determined, biotechnology company such as Celltech the story is somewhat different. Celltech was established three years ago by the British Technology Group and



Bovine-tech: ICI's Pruteen plant at Billingham produces animal feedstocks by biotechnological routes

is one of only two, truly genetic engineering companies in Britain. "The UK especially needs small companies which can easily identify new product areas," says Gerard Fairtlough. "For Celltech it would be a good thing to have a dozen Celltechs. We are a bit of an oddity. People would feel more comfortable dealing with us."

Otherwise, Vaughan and Fairtlough would like to see government action, at least at ministerial level, to make life easier for smaller companies trying to get going. Particularly valuable would be an improved purchasing policy for new drugs and diagnostics within the NHS and better tax treatment of the share option scheme for the employees of these new companies.

The Department of Trade and Industry (DTI) has issued guidance notes on purchasing policy, with the stated aim of helping smaller companies. But Vaughan points out that "is easy to say but more difficult to do". The NHS is looking for value for money, and it does not want to purchase straight substitutes for existing drugs. "In particular, it is cagey about trying something new."

Yet comparatively unestablished firms such as Celltech need the NHS's cooperation in testing new products, and the NHS stamp of approval when it comes to launching a new product in the US. Fairtlough says: "It is always safer when faced with a new fangled product from a little company to say 'no'. The attitude in purchasing should be more adventuresome. After all, we are not asking the NHS to accept products of inferior quality."

There are problems with other government schemes supposedly set up to benefit the smaller company. The system of R&D support grants, for example, which guarantees payment of one-third of the costs of a new project, does not allow for full overheads. The grants provide for between 25 and 30 per cent of total costs. Small projects, often the all-important first exploration of a technology, suffer under this scheme. Vaughan says it is "uneconomic to go through the long-winded procedures to get a little government money for projects costing less than £50 000."

Even SERC's idea of industrial clubs to carry out joint research is often not as attractive as it might seem. "The idea of clubs could benefit the small companies, by giving them access to technology," Fairtlough says, but, on the other hand, "smaller companies may not be able to afford a subscription fee of £7000."

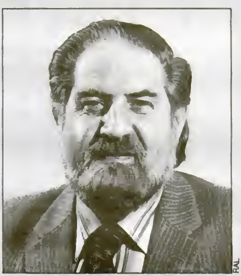
The Celltech executives reserve especially stringent criticism for the "failure" of the Department of Education and Science (DES) to do all that was possible during the recent budget cuts to ensure the existence of the biotechnologists that Britain is going to need in the future. The DES paid "lip service", Fairtlough says, to supporting the science and technology base in Britain. Not enough was done to make the system more flexible by reforming tenure for example, or changing the policy on retirement so that Britain does not lose its top people simply because they have reached a certain age. "Some of the top scientists might not have joined the brain drain if the climate had been better," Fairtlough says. □

SERC head backs his judgement with cash

GEOFFREY POTTER, head of the biotechnology programme at the Science and Engineering Research Council (SERC), has long believed that there should be a national strategy, at least for setting research priorities, with an eye to the industrial welfare of Britain. Accordingly, over the past two years, since SERC's Biotechnology Directorate was founded, Potter acted on his own advice and in consultation with industry to establish several priority areas which will take most of his £2·5 million budget, for the foreseeable future.

These range from plant genetics and biocatalysts, which Potter thinks are weak subjects in Britain, to biosensors and protein engineering, in which British research is strong. With the exception of large-scale culturing of animal and plant cells, Potter thinks Britain is level with other European countries. This is the case in the other priority areas of microbial physiology, fermenter design and downstream processing.

Potter's directorate has led the other research councils in galvanising industry, through a series of round-table discussions, to take an interest in British universities. His record in encouraging industry to participate in a variety of collaborative research programmes is impressive. For example, biotechnology projects jointly financed by industry and the SERC, under the cooperative grants scheme, have been increased from three to 17. Firms contribute about £1·7 million and the SERC £1 million. Potter's latest scheme is to organise an industrial club to support research in protein engineering at several academic centres. A group of companies met before Christmas and agreed to consider financing the club to form a multidisciplinary team to look at the detailed structure of industrially important enzymes and pharmaceuticals. If they succeed, other clubs may follow with like ideas in the areas of waste treatment and biosensors.



RAL

Potter: money for priority areas

A sizeable proportion of Potter's budget—about £750 000—goes to train postgraduates. Last year SERC commissioned a study on the supply of biotechnology manpower in Britain; it is due in the next few months. Potter says that "inevitably the sectors chosen for priority treatment would lead to certain academic departments being given preferential funding compared with most others, but this after all is what a strategy is all about. It is not about fair shares for all, but about priorities."

Crucial to Potter's plans is a close dialogue with industry, for it is industry that will eventually exploit the research "In Britain", he says, "we still haven't got it right. We still give more weight to the cultural side of science than to its application." □

The eleven dimensions of reality

Theoretical physicists are beginning to piece together a unified theory of the Universe. But they picture a strange world in which force and matter are abolished and become merely knots and kinks in the 11-dimensional geometry of space-time

Paul Davies

AN AGE-OLD scientific dream is that the physical world might be reducible, ultimately, to pure geometry; that what we see as material bodies and forces are nothing but knots and kinks in empty space-time. The idea has an appealing economy to it—the concrete substantiality of the world whipped out of a frolic of nothingness.

The first serious step in the geometrisation of nature was taken by Albert Einstein in his general theory of relativity, published in 1915. In this historic work, Einstein abolished the force of gravity, replacing it by an enigmatic field of geometrical distortion, a warping, or curving, of space-time. According to general relativity, bodies are not pulled by forces of gravity at all, as Newton had claimed centuries before. They simply meander as effortlessly as possible through an underlying warped space-time. Viewed this way, the curvature of the Earth's orbit around the Sun is not really due to a force of gravity, but is a reflection of the curvature of space-time in the Sun's vicinity. (In spite of this, physicists still find it convenient to continue referring to "the force of gravity".)

The power and elegance of Einstein's geometrical description of gravity soon inspired a little-known Polish physicist, Theodor Kaluza, to look for a more comprehensive geometrisation of nature. In 1921 Kaluza published an extension of Einstein's general relativity in which he claimed that both gravity and electromagnetism could be formulated in geometrical language, provided they were united into a single field theory. Kaluza's was the first attempt at a unified field theory, and it seemed to be something of a mathematical miracle. Kaluza showed that electromagnetism can be regarded as a form of gravity—and here was the bizarre twist—the gravity of a fifth dimension.

The ordinary space of our perceptions is, of course, three-dimensional. Relativity links space and time, so physicists have traditionally thought of the world as four-dimensional, three dimensions of space plus one of time. Kaluza proposed that there exists yet another dimension of space—a fifth space-time dimension—that we do not see. According to this theory, what we interpret as electromagnetism is, in rough terms, gravity acting in this unseen fifth dimension. The theory abolishes electromagnetic forces, just as Einstein disposed of gravitational forces, and replaces them by warped geometry, this time five-dimensional geometry. In Kaluza's theory, an electromagnetic wave, such as a radio wave, is a ripple in the fifth dimension. The most remarkable feature of the theory is that Einstein's gravitational field equations, when extended to five dimensions, should reproduce *exactly* the laws of gravity and electromagnetism in the four space-time dimensions of direct experience.

The chief weakness of Kaluza's original theory is that we do not see this extra dimension of space which plays a central role in the description of electromagnetism. Where is it?

In 1926 the Swedish physicist Oskar Klein came to the rescue by suggesting that we do not see Kaluza's fifth dimension because it is shrunken to invisibility. The situation can be compared to viewing a hosepipe from a distance. What from afar looks like a wiggly one-dimensional line, on closer scrutiny, turns out to be a narrow tube. Every point on the "line" is, in fact, a little circle around the circumference of the tube. Klein proposed, analogously, that what superficially appears to be a single, structureless point in space, is in reality a tiny circle going around the fifth dimension. We do not notice the extra dimension of space because it has been "compactified", or rolled up on itself to a very small size. Calculations put the circumference of this "tube" of space at about twenty powers of ten smaller than an atomic nucleus—far too small for us to have discerned it directly, even in sub-nuclear particle experiments.

The Kaluza-Klein theory, though intriguing, remained little more than a curiosity for several decades. It was discussed in detail by Stephen Unwin in "Living in a five-dimensional world", *New Scientist*, 29 April 1982, p 296. Since then, there has been a surge of renewed interest occasioned by some spectacular recent developments in the search for a unified field theory.

Today, physicists recognise not two, but four basic forces of nature. In addition to gravity and electromagnetism, two nuclear forces, called weak and strong, have also been discovered. Any successful unified field theory would have to accommodate these two nuclear forces as well. Significant progress along this road was achieved in the late 1960s when Steven Weinberg and Abdus Salam found a mathematical description that weaves together electromagnetism and the weak force into a single conceptual scheme. Physicists consider this a major advance in our understanding of the relationship between the different forces of nature.

During the 1970s, suggestions for further unification came from Sheldon Glashow and others, in which the strong force is merged with the newly unified electromagnetic-weak force in what have become known as "grand unified theories", or GUTs for short. The aim of the GUTs is to provide a unitary mathematical framework in which three out of four of nature's forces emerge as closely related components. The theorist's ability to subsume three apparently very different

sorts of forces under a single conceptual umbrella hinges on the discovery that these forces can all be described using so-called "gauge fields" in which certain abstract, but distinctive, symmetries occur in the structure of the force fields. The presence of these crucial symmetries already hints that some sort of hidden geometry is at work in the operation of the forces of nature. Only in the past couple of years has this geometry been made fully explicit—by appealing to the idea of further space dimensions once again.

In the Kaluza-Klein theory, electromagnetism was embodied within gravity by grafting a single extra dimension onto four-dimensional space-time. Extending their theory to incorporate the trio of forces—electromagnetism, weak and strong—demands still more dimensions of space.

The weak and strong forces are more complicated in structure than electromagnetism. For example, whereas the photon can be regarded as the "messenger" that transmits the electromagnetic force between electrically charged particles, the equivalent quantum description of the weak force demands both the newly discovered Z particle, which is identical to a photon in everything except mass, and two electrically charged messengers called W^+ and W^-. When it comes to the strong force, no fewer than eight sorts of messenger quanta (known as gluons) are needed. To accommodate all this additional complexity, the Kaluza-Klein theory has to be enlarged to involve a total of seven extra space dimensions, making 10 space dimensions plus time, or 11 space-time dimensions in all.

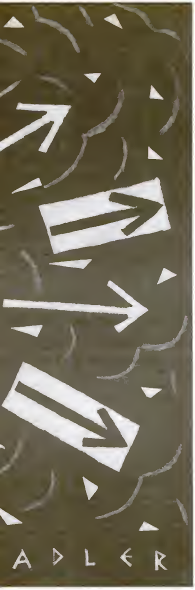
Is it conceivable that the Universe really is 11-dimensional, and that what we have always regarded as forces are actually the unseen seven dimensions at work? One man who thinks so is Michael Duff of Imperial College, London, who with his colleague Chris Pope has been developing the eleven-dimensional Kaluza-Klein theory for a couple of years. In this challenging task, intuition is of little help. Higher-dimensional spaces leave the imagination floundering. On the other hand, mathematics has no need of visualisation, and mathematicians routinely study all manner of multi-dimensional spaces for their interesting properties. One such was Elie Cartan, a French mathematician, who in the 1920s elucidated many of the geometrical properties of multi-dimensional spaces. Cartan's work, while conducted purely for its intrinsic interest, is turning out to have an unforeseen importance in the revitalised Kaluza-Klein theory.

As in the original version of the theory, it is necessary to assume that the extra dimensions are compactified, that is, rolled up somehow to a microscopic size. When only one additional dimension of space was involved, this compactification meant regarding each point in three-dimensional space as a tiny circle. In the extended theory, each point becomes a seven-dimensional compact space, and there are a great many different ways to compactify seven dimensions.

Remarkably, however, one particular choice stands apart. This is the seven-dimensional analogue of the sphere, known for short as the seven sphere. Cartan and other mathematicians had demonstrated that the seven sphere is possessed of a number of unique geometrical properties: and these, moreover, are precisely the properties required if the extra dimensions are to be interpreted as force fields.

A sphere is a highly symmetric shape, and a seven sphere embodies many additional powerful symmetries that reflect the all-important gauge symmetries on which our present description of the forces of nature hinges. However, one of the reasons it took so long for physicists to understand these forces is that, under most circumstances, the symmetries are hidden, or broken. This symmetry-breaking may be reproduced in the Kaluza-Klein theory by allowing the seven sphere to be slightly distorted, or squashed. The squashed seven sphere is emerging as the most favoured shape for the unseen dimensions of space.

The new Kaluza-Klein theory has proved so inspiring to theoretical physicists that they have been rushing to adapt all the laws of physics from 4 to 11 dimensions. One obvious problem to be tackled is to find a reason why an 11-dimensional space-time should arrange itself into four



Alan Adler

plus seven. The hope is that this configuration represents, in some sense, the lowest energy state of space-time. In physics, systems generally seek out a state of minimum energy, so it is possible to believe that when the universe was created, all 10 dimensions of space existed on an equal footing, but that somehow seven of them spontaneously decayed, curling up into a shrunken ball. If the idea is correct, it opens up a tantalising possibility. Perhaps the unstable seven dimensions remained active for long enough in the primeval cosmos to leave an imprint on the structure of the universe, an imprint that remains to this day?

The most spectacular such possibility is that the seven vanished dimensions will provide an explanation for the big bang itself. The ultimate cosmic mystery is the cause of the explosion which brought the physical Universe into being about 15 billion years ago. The only force known to us that can take control of the entire Universe is gravity, but in all our experience gravity is attractive—it is a pulling force. The explosive outburst which marked the creation of the Universe requires a pushing force of unimaginable power to blast the cosmic fragments apart and set the Universe on the path of expansion. Very recently, theorists have discovered that unified force fields naturally tend to produce just such a repulsive force under the extreme conditions expected in the big bang.

One conceivable scenario for the creation goes something like this: In the beginning, 11-dimensional space-time erupted spontaneously out of literally nothing, an event that is only explicable within the context of quantum physics, which permits the uncaused creation of physical structures. The shape of space need not initially have been specially ordered; it could have been chaotic and turbulent. In some regions, inevitably, the configuration would have been such that the competition of forces produced a huge repulsion. As a result, three space dimensions began to expand at an accelerating rate, while the remaining dimensions spontaneously rolled themselves into a seven sphere. If the outward driving force could sustain itself for long enough, the explosive violence characteristic of the big bang would be achieved.

At this stage such ideas can only be tested by calculation. Would the repulsive force have lasted long enough? Is it inevitable that three dimensions of space embark upon expansion while seven collapse, or could there be a different split, say, two plus eight?

It may be that even the number of starting dimensions is variable,and that 11 has been selected anthropically too. There is, however, some curious independent evidence that suggests the number 11 is unique. It comes from a branch of physics which sets as its goal the formulation of a mathematically consistent quantum theory of gravity. For some time, physicists have been greatly distressed that the general theory of relativity, whatever its intrinsic merits, clashes badly with the principles of quantum physics.The only way out of this impasse seems to be to embed general relativity in a more comprehensive theory of gravity which involves extra components— types of gravity we haven't yet seen. According to this philosophy, all the mathematical troubles with quantum gravity have arisen because physicists have been artificially isolating what is actually only a fragment of the full panoply of gravitational forces.

To achieve a complete theory of gravity—one which will be consistent with quantum physics—the gravitational force of familiar experience has to be fitted together snugly (in a mathematical sense) with the additional, as yet undetected, gravitational components. For the past decade, an army of theorists has been engaged on this daunting enterprise. Their work has centred on a key idea, called supersymmetry. This is an abstract mathematical concept related to the phenomenon of intrinsic spin found among subatomic particles. The technical details do not matter here. The point is that the most elegant formulation of a supersymmetric theory of gravity is one in which space-time has 11 dimensions!

Is this just an improbable coincidence, or does it point compellingly to a deep connection with the unified gauge theories of the other three forces of nature? Is the mathematics hinting at a fully unified field theory, in which gravity and other forces are merged into a single superforce? If so, then that age-old dream of building the world out of pure geometry could be close to realisation—but the geometry would be that of an 11 dimensional universe. ☐

Paul Davies is professor of theoretical physics at the University of Newcastle upon Tyne. His latest popular book is *God and the New Physics* (Dent).

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Why we need evolution by jerks

Punctuated equilibrium is attracting an enormous amount of interest. Is this because, like fundamentalist creationism, it offers an escape from 'the beast within'?

John Turner

THE IDEA that evolution occurs by leaps and bounds, the "punctuated equilibrium theory" (or as I sometimes call it "evolution by jerks") of Stephen Gould and Niles Eldredge, was destined to come into being from the day in 1963 when a quiet, brilliant graduate student at the London School of Economics published a paper called "The evolution of altruistic behaviour". Its author, the now eminent biologist W. D. Hamilton, will probably be as surprised by this statement as the rest of you are puzzled. I had better explain.

We must go right back to Charles Darwin. His central scientific insight was that organic diversity and the beautiful adaptations of animals and plants to their environments had one single cause—natural selection. Like many such original ideas it is obvious once you say it. That this implied that *Genesis* was not literally true was a worry to some people, but the minor worry to many. The theologians of the Higher Criticism had for years maintained that the *Bible* was not an infallibly literal account of history. What really hurt about Darwin's theory can be seen from the kind of jokes that *Punch* made about it. There are of course no God in the Garden of Eden jokes; these would be considered blasphemous. But there are not even any of those cartoons where a wriggly, slimy trail by the beach changes into a series of footprints that finally walks away, fully human after a few metres. Those came in the 20th century. What the Victorians got was gorillas, gorillas and, after that, more gorillas. Du Chaillu's book on the wild gorilla, published not long after the *Origin of Species*, aroused great interest, and there they stalk through the pages of *Punch* scaring the trousers off footmen, demanding to know "Am I a man and a brother?"

What made these jokes so deeply and painfully humorous is obvious. Bishop Samuel Wilberforce summed it up eloquently: "Man's derived supremacy over the earth; man's power of articulate speech; man's gift of reason; man's free-will and responsibility; man's fall and man's redemption; the incarnation of the Eternal Son . . . —all are equally and utterly irreconcilable with the degrading notion of the brute origin of him who was created in the image of God . . . " Who cares about the special creation of ten thousand species of roundworm? But where are we morally and spiritually if we are nothing more than smart gorillas? As one divine put it, it was revolting to think that our noble nature was nothing but the perfection of the malice of the ape.

Natural selection stopped at the mind

But where did the noble part of our nature come from? What eternal feminine was leading us on high? Agnostic Huxley declined to invoke God. Alfred Russel Wallace, who embraced spiritualism later in life, was convinced that there were aspects of the human mind that simply could not be explained by natural selection, and hence that during our ascent something of the divine had entered into us. Indeed, how could natural selection explain a creature that often behaved with such moral fortitude and such disregard for its own individual survival? What gorilla would let itself be burned alive for the sake of denying that bread was flesh or flesh bread? What chimpanzee would sink in its thousands in the mud of Passchendaele for Kaiser, King and country?

And so it was until 1963 that one could without too much discomfort believe, even as a scientist, that Darwinism stopped at the human mind. Then Bill Hamilton took the stopper out. Like most zoologists, who feel uncomfortable writing about their own species, he dealt strictly with animals. He explained, in a principle now widely known as "kin selection", how they could evolve limited forms of altruistic behaviour along strictly Darwinian lines, so long as the altruism was not too self-sacrificing and was expended on a close enough relative. The new science of sociobiology was born.

Its first effect was to make animals look more human. But the corollary could not be escaped: the thesis could make us more animal. If apes were, after all, not *that* malicious, maybe what was noble in our nature really was a perfection of theirs.

Twentieth-century man was as upset by the new attempts to link him to the animal as his Victorian ancestors had been by Darwin. It was the turn of E. O. Wilson and Richard Dawkins to be denounced, not this time from the pulpit as atheists, but by radical movements as fascist sympathisers. A Harvard group denounced Wilson's work as being in the intellectual tradition of Adolf Hitler. Realising that this tactic was so manifestly unfair as to be counterproductive, the group has since modified its tone. British radicals failed to get this message; *Nature* recently published a statement pointedly asking British scientists with interests in sociobiology to dissociate themselves from the National Front.

Government by genes

The radical opposition to the idea that sociobiological thinking can be applied to certain aspects of human behaviour, when it is unwrapped from its political terminology, is the same concern that motivates the creationists. Monty White, a British biblical fundamentalist, put it beautifully in a BBC interview: "If you tell people they're animals, they'll behave like animals." That the "human" behaviour the creationists want to preserve is the very *Küche, Kinder, Kirche* order of society that sociobiology's opponents want to tear down, adds an exquisite irony. When I find that radicals accuse sociobiologists of trying to abolish our free will in favour of genetic determinism—the idea that what we do is governed by our genes—I begin to suspect that we have a debate that is, at bottom, void and without form.

But for a radical materialist, sociobiology is a spectre not readily laid. It has been too successful in explaining animal behaviour ever to be wiped off the intellectual map. What is needed is to get our own species out of the zoo again. Now many of us might feel that although some human behaviour might be based in our animal past, much of it clearly is not. There are no genes for making or inventing colour television sets or wearing digital watches, at least none over and above the genes that allow us to be inventive and imitative. There *might* be genes that push us, more or less, toward monogamy and the avoidance of close incest. Why this moderate view just will not go into the opposition's calendar can be understood from the following sentence from *The Human Biogram* by Lionel Tiger and Robin Fox: "We behave culturally, because it is in our nature to behave culturally, because natural selection has produced an animal that has to behave culturally, that has to invent rules, make myths, speak languages, and form men's clubs, in the same way that the hamadryas baboon has to form harems, adopt infants, and bite its wives on the neck."

This treads on the toes of feminists (who needs men's clubs?), rationalists (who needs myths?), and anarchists (who needs rules?), and is largely hot air anyhow. But if we do admit that we may have innate capacities for language (which offends only Washoe-fans), we open a box of troubles. For those bits of our behaviour that are most likely to be

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explicable in sociobiological terms are the very aspects of our own reproduction, family structure and defensive behaviour with which the radicals are most concerned. Admit a genetic explanation for one behaviour, and you might find you've given hostages to fortune. Writers opposed to human sociobiology have therefore retreated firmly behind Sartre's dictum, "there is no such thing as human nature".

This creates problems for them. If the human brain did really evolve, how did it manage to float free, like the breasts of Tiresias, from the old set of animal instincts? What Promethean god gave us the genes to free us from our genes? Stephen Gould, who has repeatedly urged the need to see man as essentially different from animals, and was one of the signatories of the "Hitler" statement about E. O. Wilson, has found the answer in the punctuated equilibrium theory. The crucial point of this theory is to deny Darwin's central synthesis: that adaptation and diversity have the same causes. Diversity is generated non-adaptively by the comparatively sudden origin of new species in some kind of evolutionary "jerk". This smashes human sociobiology in two ways. First, as evolution is not always adaptive, it is useless to argue, as sociobiologists do, that certain human practices may have been bequeathed to us by a long history of natural selection. Secondly, if evolution is essentially *discontinuous*, it is futile to look for traces of our animal past. As Sir Edmund Leach, a staunch advocate of purely human humans, put it recently at the British Association meeting in York, a good biologist should now prefer the new theory of Gould to the neo-Darwinism of E. O. Wilson.

"Come along. Don't stand looking at that—which I call it shameful o' them prefane Darwinites! I don't believe it's a bit like Her!"
Punch *1878*

But surely, you will say, such a debated scientific theory must be based on something better than this! Well, it is and it isn't. The original observations of Niles Eldredge, that fossil lineages tended to show very little change over very long periods and then to alter so rapidly that the intermediates were not detectable in the fossil record, introduced evolutionists to the idea that the fossil record, far from being so imperfect as to be useless, was actually telling us something about evolution. No one should belittle this: it is a real advance in thinking. But the idea that evolution does not occur at a constant speed was not unfamiliar to neo-Darwinians, and is not a point of difference between them and the proponents of punctuated equilibrium. Neo-Darwinists believe that the periods of stasis are produced by "stabilising selection", an active maintenance of the status quo exerted by all species on each other once they have filled up all the ecological niches in a habitat. The rapid changes occur either when the physical environment alters, or when the extinction of a species empties an ecological niche, giving the surviving species a chance to move into it. We can show that most evolutionary changes of this kind will be accomplished within the 50 000 years which punctuationists admit to being a geological microsecond. On these points there is simply no difference, except in terminology, between conventional neo-Darwinism and evolution in jerks.

What distinguishes the rival theories is the punctuationists' belief that the jerks, first, are generated by some process different from adaptive evolution and possibly still unknown; and secondly, that they always accompany the branching of the evolutionary tree, the process known as cladogenic speciation. It is only these ideas that make the punctuated equilibrium theory "new" and "different" from the older theory. There is no good evidence for them: I am tempted to say no evidence at all. Of the essential jerk theory, one can say as Gould did of sociobiology, that it brings no new insights, and can cite on its behalf not a single unambiguous fact.

The same situation has occurred at least once before in the history of evolutionary theory: when geological stratigraphy made a literal interpretation both of the rocks and of the *Bible* increasingly difficult, Baron Georges Cuvier invented his own theory of punctuated equilibrium. The world, he said, had been destroyed by a series of cataclysms which were recorded in the rocks. If one liked, one could believe that *Genesis* recorded the last of them. Cuvier's old catastrophe theory provided the same kind of philosophical relief that can now be provided by Gould's new catastrophic theory. Without being too explicit, for no one could claim to understand what happened in a geological catastrophe any more than in a punctuational event, one could have one's cake and eat it.

The point is not that the punctuated equilibrium theory is wrong. It might be right. The point is that despite its very poor scientific foundations it is attracting an enormous amount of attention. And as the Harvard radicals so cogently argued in the case of race and IQ, when an essentially meretricious scientific theory causes such a fuss, we must look to quite non-scientific causes. In this case it is the role of the punctuated equilibrium theory in saving us from the beast within, who before he was du Chaillu's gorilla and Thomas Huxley's ravening wolf, was Caliban, and Beelzebub, and Seth.

And would the author tell us what *he* thinks? I don't much like -ism-schisms: they usually turn out to be debates about the wrong thing. When Disraeli asked whether man was an ape *or* an angel, what mattered was that he considered no other possibility, no middle way. A century earlier the schism would not have existed. I prefer Pope's description of our species:

> Placed on this isthmus of a middle state,
> A being darkly wise and rudely great . . .
> He hangs between; in doubt to act, or rest;
> In doubt to deem himself a god, or beast . . .
> Created half to rise and half to fall;
> Great lord of all things, yet a prey to all;
> Sole judge of truth, in endless error hurl'd;
> The glory, jest, and riddle of the world! ☐

Dr John Turner is reader in evolutionary genetics at the University of Leeds, and writes especially about the origins of mimicry in butterflies and the history of evolutionary theory in the 20th century.

REVIEW

A loner, a misfit, a genius

Alan Turing: The Enigma
by Andrew Hodges, *Hutchinson/Burnett, pp 587, £18*

Donald Michie

A SINGLE scene may yield many views—as many as there are observers. Yet all views may be true and none overlapping. Alan Turing's unpublished lecture of 1947 to the London Mathematical Society (some telling excerpts are reproduced in this book) can now be inspected, with other Turing memorabilia, in King's College Library, Cambridge. A colleague of great eminence in the theory and methodology of computation recently wrote to me after reading the original typescript: ". . . incredibly accurate prediction about progress in logic and computational complexity". True. Yet before being shown this particular view, my own mind was mesmerised with the accuracy and prescience with which Turing laid out the problem of automatically acquiring and organising knowledge, a topic central to today's study of artificial intelligence.

So rich is the terrain revealed in this little-known lecture that those with other backgrounds will seize on other insights, for example into problems of computer design. But to have such topics pursued, expounded, and set in their context and in their time, must await a quite different book from the one that Dr Andrew Hodges has written.

This reconstruction of Turing's strange personality and consequential life is written by a mathematician. Yet this circumstance is patently very far from the driving interest which impelled Hodges through the years of search and sifting, to piece together this marvellous and faithful collage. At rare moments in the narrative, contact is made with the technicalities of Turing's professional contributions. Thus Turing's establishment in the 1930s of a formal basis for computation and decision, his advances made during the war in the methodology of uncertain inference, and his later analysis of problems of computer hardware design and of the logical strategy for future artificial intelligence research—all are embedded in the text, skilfully garlanded with anecdotes.

The skill, though, is that of the novelist and the dramatist. During the occasional moments of technicality the book trips and stumbles more often than it should. This is not because the author could not have done the extra homework. Rather, we should ask ourselves why the reader should expect an author to have time and energy left, after pouring so much into his main theme.

So what was the author's main task? How far has Hodges accomplished it? What was the absorbing interest which drove him through it?

The main task was clearly to draw a living thread from Alan Turing's childhood and schooldays to his death by suicide at the age of 42, to interweave the thread through the patterns of the central character's private life and public acheivement, and in so doing to recreate the personality and emotional odyssey of one of the intellectual movers of our world.

Andrew Hodges never met Turing. Yet he succeeds astonishingly. Those of us who knew Alan Turing instantly recognise their one-time colleague in now delightful, now painful detail. It is all here—the irritating quirks and the funny ones, the indestructible stamina of the long-distance loner, the volcanic capacity for fun of the nihilist, the simplicities of the eternal schoolboy, the readiness to attack bare-handed any problem which offered the remotest chance of reducibilty by reason.

The reviewer who does not pluck out for display at least one good story cheats his readership. So here is Peter Hilton's account of the occasion when Turing, employed as a civilian cryptanalyst at Bletchley Park, was enlisted in the Home Guard. Alan

❛had to complete a form, and one of the questions on this form was: "Do you understand that by enrolling in the Home Guard you place yourself liable to military law?" Well, Turing, absolutely characteristically, said: "There can be no conceivable advantage in answering this question 'Yes'," and therefore he answered it "No". And of course he was duly enrolled, because people only look to see that these things are signed at the bottom. And so . . . he went through the training, and became a first class shot. Having become a first class shot he had no further use for the Home Guard. So he ceased to attend parades.

And then in particular we were approaching a time when the danger of a German invasion was receding and so Turing wanted to get on to other and better things. But of course the reports that he was missing on parade were constantly being relayed back to Headquarters and the officer commanding the Home Guard eventually summoned Turing to explain his repeated absence. It was a Colonel Fillingham, I remember him very well, because he became absolutely apopletic in situations of this kind.

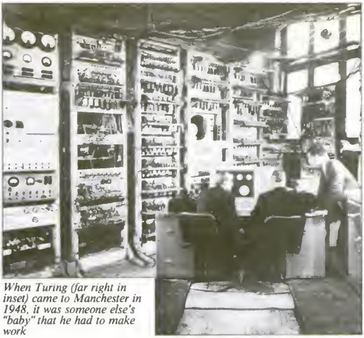
This was perhaps the worst that he had had to deal with, because Turing went along and when asked why he had not been attending parades he explained it was because he was now an excellent shot and that was why he had joined. And Fillingham said "But it is not up to you whether you attend parades or not. When you are called on parade, it is your duty as a soldier to attend." And Turing said, "But I am not a soldier." Fillingham: "What do you mean, you are not a soldier! You are under military law!" And Turing: "You know, I rather thought this sort of situation could arise," and to Fillingham he said: "I don't know I am under military law."

Anyway, to cut a long story short, Turing said, "If you look at my form you will see that I protected myself against this situation." And so, of course they got the form; they could not touch him; he had been improperly enrolled. So all they could do was to declare that he was not a member of the Home Guard. Of course that suited him perfectly. It was quite characteristic of him. And it was not being clever. It was just taking this form, taking it at its face value and deciding what was the optimal strategy if you had to complete a form of this kind. So much like the man all the way through.❜

The habit of forceful derivation from a few simple principles tends to be upsetting to the "normal" world, based as it is on the companionable blurring of distinctions, on the tactful avoidance of literalness and on respect for tribal gods. Turing was not unaware of the tendency to upset, as can be surmised from Hilton's anecdote and from much else in Hodges's book. In my view Peter Hilton's summing up, "So much like the man all the way through", should be taken further even than Hilton perhaps intended. Much of Turing's working method and intellectual style, not just his day-to-day doings, could be characterised as destructive of tradition, assertive of the self-reliant self.

Here was a man capable of rediscovering from scratch Gauss's central limit theorem, leaving the fellows of King's puzzled as to whether to elect the fellowship candidate for originality or to reject him for ignorance. What other kind of man could arrive at the famous decidability result by means of so bizarre and childish-looking a construction as the Universal Turing Machine?

Turing, the long-distance runner



When Turing (far right in inset) came to Manchester in 1948, it was someone else's "baby" that he had to make work

Turing's remarkable treatment, so far from mainstream styles, must have jarred on well-dressed minds. Yet it was this work above all, in setting the logical base to all that computation has become, which opened a new age to mankind. Today we recognise this new beginning as the dawn of a second industrial revolution, more profound than the first.

So we now ask what imparted and maintained the impetus of this biography. In the author's note at the end, Hodges writes: ". . . in 1973 the name of Alan Turing impressed itself on me again, this time through another compartment of my life. I was then a member of a group that had formed within the London Gay Liberation Front . . . One of the other members, David Hutter, had heard something of the end of the Turing story from Nick Furbank . . ."

Alan Turing was a homosexual. His suicide in 1954 was preceded by incidents in which he had been caught on the wrong side of legislation which by today's standards was irrational and oppressive. Hodge's own passionate convictions on the subject have set the pace, motivation and interpretative tone of his book. Towards the end this motif intensifies, and I would say distorts. Turing was certainly both agitated and depressed by the unnerving fix that he had got into, as I remember from a talk with him at the time. But my feeling is that a deeper factor was at work in lessening his will to live.

I believe that growing concern that the wellspring of creative capacity in himself might be drying up was the key: the rest were triggering factors. Such apprehensions are by no means confined in life's middle years to those who are actually endowed, as was Turing, with creative capacity. Nor do these dark nights of the soul necessarily lead to suicide. But for Alan Turing, the fall-backs to prepared positions —socially contributory hack work, family life, easy companionship and relaxed friendships —where re-grouping can be achieved for some new stable niche or *pour mieux sauter*, these positions did not exist. So the edge of the abyss was always a little nearer than for that class of humanity described by Gibbon as "decent easy men".

Hodge's theme is the social deviant crucified. Over against the victim stands society's organised mediocrity. As the story moves to its tragic finale, CIA and MI5 persecutors are thrown in to swell the ranks of the pharisees. At times the theme leads the biographer into speculative flights, far beyond the bounds of ascertainable fact.

This of course is a pity, and if it were so of a lesser book it would be a serious flaw. But to prevail against the magnitude of the task which Hodges took on required supernormal intensity and dedication. I believe that the passion of a cause was the necessary fuel, and now that he has succeeded against the odds it does not seem appropriate to complain. A dozen pettifogging chronicles and scholarly exercises in factology could have been written, perhaps more accurate and certainly more balanced. But they would have been of little use compared with this gift of Andrew Hodges.

This is not a book to be argued about. It is a book to be read. ☐

Postgraduates still struggle

How the PhD Came to Britain
by Renate Simpson, *SRHE*, pp 204, £9.75*

Paul Simons

POSTGRADUATE education in this country is slipping badly. Increased fees reduce the numbers of overseas students; cutbacks hit research grants and facilities; research councils have attacked the numbers of students failing to complete their theses; and perhaps most important of all, there is the lack of jobs at the end. All have badly mauled this once prestigious institution.

We can either blame it all on the economy, or take a more personal swipe at students unsuited to postgraduate work, or maybe lecturers with a somewhat lackadaisical attitude. Certainly the research councils take the matter seriously; one council has even issued guidelines to its lecturers and postgraduates on how to get on with one another and the research project. Fresh opportunities, and particularly money, have been sought together with stronger collaboration with industry; but we might well ask what is the whole purpose of a PhD—is it something of a museum piece, and what was it originally intended for?

The answers partly lie in the agonisingly protracted birth of the British PhD, revealed in this publication—which is itself a masterpiece of research (one key source of information at the Universities Bureau of the British Empire in London was bombed to destruction in 1940).

The story is a sorry tale of almost complete indifference to science research both in parliament and the establishment as a whole.

The PhD epitomised science research as a whole, and in 19th-century Britain it seemed trifling when the Empire could apparently function perfectly well on abundant cheap labour and materials. Never mind that the German universities were forging ahead with well-organised science teaching and vigorous research, and had introduced their PhD in the early part of the 19th century.

University of Dundee

Meanwhile Oxford and Cambridge were moribund in an antique college system, and serious science graduates turned instead to the German universities for their PhD research. On their return home these invigorated postdoctorates fought hard for the sort of facilities they had come to expect, and pressured parliament along with a powerful group of science politicians based in London. Eventually their influence led to a boom in new universities across the country towards the end of the 19th century: but still there was no British PhD.

The crunch came during the opening of the First World War, when Germany cultivated political influence in neutral America by corresponding with its old postdoctorates, many of whom were in positions of some political power. Meanwhile, how long could Britain hold the hearts and minds of its own colonies as they sent over hundreds of thousands of men to fight for King and Empire? And at home, as the drive for self-sufficiency got under way, it was becoming embarrassingly clear how much industry had come to depend on German know-how.

So the British PhD was born out of political expediency, the essence of which has changed precious little since. Certainly a historical perspective is crucial to understanding the birth of the PhD, and a more general historical background would have helped throughout the book. Simpson is most at home with meticulous documentation of the events most closely associated with the PhD, but the relentless catalogue of meetings, papers, people and institutions made my head spin. Nevertheless, this is an invaluable academic companion to *The Highest Education* by Ernest Rudd (Routledge, 1975), in which Simpson collaborated, and which gives a detailed insight into the state of modern postgraduate study in Britain.

The value of the PhD to both science and country as a whole should not be forgotten in today's depressing climate. ☐

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*Society for Research into Higher Education, University of Surrey, Guildford, Surrey GU2 5XH. Publication costs SRHE members £6.50.

Stories from Ancient Greek

Science, Folklore and Ideology
by G. E. R. Lloyd, *Cambridge UP, pp 260, £25, pbk £8·95*

Roy Porter

THE GREEKS were the founding fathers of science. It was they who rejected the cosmos as the battleground of the gods, and formulated the idea of Nature—orderly, harmonious, governed by laws; they who had faith in man's power to understand Nature by reason, probing it with observation and experiment, and writing down their ideas systematically; they who laid the foundations of matter theory, geometry, astronomy, natural history and medicine. And all this, standard histories tell us, was the achievement of a handful of towering geniuses: Hippocrates, Pythagoras, Aristotle, Euclid, Archimedes etc.

Geoffrey Lloyd doesn't want to topple these giants. But he contends there are other stories to be told about Greek science, and the fascination of his book lies in posing the questions so often passed over. Great scientists don't operate in a vacuum. What then were the intellectual matrices of Greek science? What were the relations between science—objective and rational—and what did the average illiterate Greek think about plants, animals, diseases, life? What did the scientists learn from bearers of vernacular knowledge such as root-gatherers and midwives?

Ingram Pinn

The links were rich and varied. In some cases, naturalists simply incorporated folklore without question. Thus Theophrastus warns we mustn't gather a certain herb in daylight, or woodpeckers will peck out our eyes. In other cases, scientists scoffed at the ignorance of the hoi polloi. With his superior insight into taxonomy, Aristotle revealed the whale was not a fish. Whatever superstitious midwives might say, don't cut the umbilical cord with a crust of bread, orders the physician Soranus: use a knife.

Yet very frequently Greek science rationalised popular prejudice. Aristotle "proved" that brutes were defective humans, and women were mutilated males. Such views—anthropocentric and misogynistic—had been the traditional gut feelings of Greek men. But Aristotle gave them a scientific cogency that lasted for millennia.

So Greek science built on folklore in complicated ways. In some cases the dawn of science brought open-mindedness. As Lloyd points out, with the Greeks, every theory had its counter-theory. Because investigators didn't hold public office, and there were no research institutes, science was a bit like Speaker's Corner. Though this very diversity could itself have drawbacks. For example, the Greeks never imposed a standard nomenclature in botany or anatomy. In fields like pharmacology, confusion over terms remained a bugbear. Yet in other cases, fossilisation was the danger. Once written down, scientific opinion acquired an odour of sanctity, which could stifle inquiry. Why was the Roman naturalist Pliny inferior to his Greek predecessors? Because he'd become an armchair scholar, resting on the laurels of his library rather than going out and seeing for himself.

We are all used to thinking of Robert Hooke down amongst the lens-grinders and of Charles Darwin learning from pigeon fanciers. The merit of Geoffrey Lloyd's book lies in helping us to see Greek science in the same way. And, planted firmly within their own culture, the great names themselves come alive in a new way. ☐

How mathematics grows

The Nature of Mathematical Knowledge
by Philip Kitcher, *Oxford UP, pp 287, £15*

John Little

IS THERE any real difference between mathematics and science? The conventional answer is that whereas science deals with truths about the world, mathematics deals with truths about some abstract realm; and that whereas today's truths of science are likely to be consigned to tomorrow's graveyard, the truths of mathematics are timeless.

Some philosophers have taken a different view. John Stuart Mill proposed that mathematics is a natural science no different from others. His rather crude attempts to show that, for example, we know that $2+2=4$ because we observe that combining two groups of two bricks gives us four bricks, were ridiculed by more mathematically sophisticated philosophers.

Yet, in recent decades, Mill's position has gained respectability again. In *The Nature of Mathematical Knowledge*, Philip Kitcher takes on the mantle of Mill and sets out to provide the first fully articulated empiricist theory of mathematics. He begins by tracing the knowledge of individuals to the knowledge of their communities, and in particular to the mathematical authorities in those communities. The knowledge of those authorities he grounds in the knowledge of earlier authorities. The chain is ultimately grounded in rudimentary knowledge acquired by our remote ancestors through ordinary sense perception—by manipulating the world and observing those manipulations. The vast panorama of modern mathematics has grown from humble roots in elementary truths of arithmetic and geometry derived from practical experience.

Though philosphers might throw up their hands in despair, most people would see little controversial in Kitcher's thesis. After all, as infants we all started off with building blocks (practical experience) and ended our mathematical journey when we became incapable of ingesting the information offered by teachers (community authorities). Indeed, Kitcher might well have profited by buttressing his historical arguments with the work of psychologists interested in the way that mathematical knowledge is generated in the infant.

Kitcher's view is that mathematics consists in idealised theories of ways in which we can operate on the world. Obviously the question of how mathematics *grows* occupies much of the book. Here Kitcher sees his task as showing how mathematics can be integrated within a general account of rational inference (which would apply equally well to the growth of scientific knowledge). Briefly, great innovators adopt a practice based on a rational transition from traditional practice.

Kitcher explores an area largely avoided by philosophers (with the notable exception of Imre Lakatos). The language and symbolism of mathematics, the nature and standards of what constitute a valid proof, even the type of questions which are seen as important, all change over historical epochs. The book closes with a historical case study—the development of analysis from Newton and Leibnitz to the beginning of the 20th century—in which we can see these factors at work. Kitcher argues that mathematics often develops quite rationally, through non-rigorous responses to interesting problems whether practical or theoretical. Historically this would seem to be fully justified and it brings mathematics into line with recent thinking on the development of science.

The Nature of Mathematical Knowledge has an important role, both in stimulating further work on empiricist theories of mathematics and as a target for the attacks of hostile philosphers (indeed much of the book is taken up in an attempt to foresee and rebut these attacks). Whatever the outcome it provides a valuable alternative way of looking at mathematics. Only by looking at mathematics from as many different angles as possible can we see features that are hidden from any one perspective, and begin to appreciate its richness and diversity. ☐

Don't panic—it's only stellar evolution

100 Billion Suns: The Birth, Life and Death of the Stars
by Rudolf Kippenhahn, *Weidenfeld & Nicolson, pp 264, £15*

Ian Robson

WHEN a package arrives from a magazine with a book to be reviewed, I always hope it will be a book which I really want to read. When I looked at the title of this book and read the accompanying letter from our worthy review editor, I inwardly groaned. A quick skim through the book reinforced my first impression. Therefore, when I say that I thoroughly enjoyed reading it, and spent much more time than I originally intended, then the reader will need to believe that this book is something out of the ordinary.

Something special it is: a book on a complex subject, stellar evolution, presented for the layperson. I am well aware that there are numerous books on the market which present astronomy for the layperson—I have a shelf full of them—but this book is very different. Rather than cover astronomy from Stonehenge to 2001, Rudolf Kippenhahn sticks to one topic and covers it comprehensively. The uniqueness lies not in how the book is organised; this is quite conventional. The special character is given by the author himself.

Obviously a master of the subject, having spent a lifetime of research in the field, he presents the subject to a lay audience in words which people can readily understand. Those of us who give lectures and talks to all types of audiences ranging from the local Women's Institute to the Brewers and Allied Workers (research seminars fall somewhere in between), know that the biggest problem is the jargon. Not only the very specialised jargon we use but the common terms in physics which are equally as baffling to a lay audience. In overcoming this communication barrier, Kippenhahn is a master.

I suspect that many of my professional colleagues will loathe the book for such phrases as [the photons] "are swallowed and after a while are again discharged" when describing radiation transport within a stellar atmosphere. But a lay audience will know just what the author means when he describes the process as such. No matter that we really need talk about pressure gradients, the use of very simple language and illustrations will get the fundamental message of stellar stability across. Another example is to be found in the sentence "In many stars matter begins to seethe when radiation fails to do its job, and convection must take over the transfer of energy". Great stuff, and if this conveys the feeling of what is going on then the book is for you.

I wonder how many of us professionals could read this book and honestly say we knew everything contained therein. I make no apology when I say that there were some points which had been hazy in my mind and which the book clarified. I also learned some interesting history because Kippenhahn frequently relates discoveries to people and many of today's leading astronomers get worthy mentions.

The text is presented in relatively large print with wide spaces between lines, almost like the "Don't panic" written across the face of another well-known book. Line drawings abound in plenty and are clear if not outstanding in their presentation. The whole book suffers from this lack of glossy approach and at £15 it is not cheap. If it were in paperback I would insist that all my degree students buy it as background reading for their third-year stellar evolution course. If they understand all the physical concepts and interrelations presented in the book, their grasp of stellar evolution will be excellent.

There are few photographs but five colour plates add a touch of gloss. The spelling is mostly American as against English, although the preface insists this is an English translation of the original 1980 German edition. The author does not promise the book is completely up to date in the field (and it is not), but what matter? With the author's ability to discuss the nitty-gritty of key points of stellar evolution, the text does not need to have every last experiment or computer calculation included —and is probably the better for it.

By concentrating on the key issues in a well defined but light hearted style, Kippenhahn has produced an excellent and most readable book which I thoroughly enjoyed despite initial misgivings. Come on all you amateurs or armchair enthusiasts out there, read it and enjoy astrophysics as it really is. ☐

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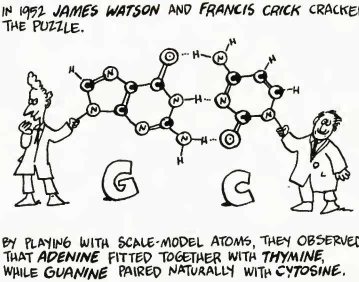
Making fun of genetics

The Cartoon Guide to Genetics
by L. Gonick and M. Wheelis, *Harper & Row, pp 214, £3·95 pbk*
DNA For Beginners
by Israel Rosenfield, Edward Ziff and Borin van Loon
Writers and Readers, pp 224, £3·95 pbk

Steven Rose

DNA? IS THAT A GOVERNMENT AGENCY?


IN 1952 JAMES WATSON AND FRANCIS CRICK CRACKED THE PUZZLE.
G
C
BY PLAYING WITH SCALE-MODEL ATOMS, THEY OBSERVED THAT ADENINE FITTED TOGETHER WITH THYMINE, WHILE GUANINE PAIRED NATURALLY WITH CYTOSINE.

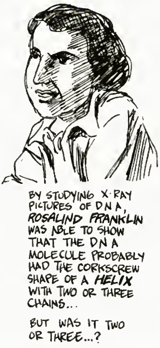
Cartoon Guide to Genetics

IN THE beginning (or at least, the one I saw) was Rius's witty cartoon guide to the history of Cuba, from colonialism to Castro. It was clearly a winning streak, and cartoon beginners' books are springing up all over; the route map at the back of *DNA for Beginners* lists titles ranging from sex and atheism to the mafia and Wagner, from the Communist Manifesto to Einstein. And successful innovations obviously spread, though it is not clear whether the Gonick and Wheelis *Cartoon Guide to Genetics* is itself the forerunner of a whole new series by a different publisher.

Such books, to work, must fulfil a number of criteria. First, they must choose a field of major conceptual or historical importance, not merely to specialists but to a wider audience. Secondly, they must illustrate both its internal content and wider relevance in a way that makes it transparently accessible. And thirdly, they must achieve this by a combination of pared-down text and witty drawings. How well do these texts match up?

Clearly the theme of genetics —ranging from why our own children resemble/differ from us to genetic engineering, from practical farm breeding to the arcane recombinant laboratories, and with a history of at least a century of intense scientific, philosophical and ethical controversy—is ideal. But it is a subject full of complexity. Traditional genetics teaching starts from Gregor Mendel, takes us through cytogenetics to the DNA code, and then merges with molecular biology. It makes uneasy branches out to population and developmental genetics, and may or may not take on a bit of "socially responsible" history, from tut-tutting about Lysenko to fretting about the genetics of behaviour and the ethics of cloning.

The problems with this approach are that the different branches of genetics fail to become integrated, and the most interesting questions, such as those of development, receive short shrift. If Mendel's laws are made the starting point, as they are in at least most basic courses, then the fact that they are exceptional special cases and that most phenotypic traits are not transmitted in a Mendelian manner becomes a painfully difficult stumbling block. And if molecular biology and DNA are the starting points then the complexities of developmental and population approaches are likely to suffer from a naive reductionism. Beginning with the relationship of genotype to phenotype, ontogenesis and the norm of reaction, makes for much more coherent understanding.


BY STUDYING X-RAY PICTURES OF DNA, ROSALIND FRANKLIN WAS ABLE TO SHOW THAT THE DNA MOLECULE PROBABLY HAD THE CORKSCREW SHAPE OF A HELIX WITH TWO OR THREE CHAINS...
BUT WAS IT TWO OR THREE...?

In fact, both these books are quite orthodox in their approach. Larry Gonick and Mark Wheelis take us on a quick romp through Jacob's biblical sheep-breeding practices and Mendel to one-gene-one-enzyme, DNA, recombinants and, finally, biotechnology as big business. The drawings are often good fun and even instructive. If you can't learn Mendelian genetics from this text, I guess you never will.

There are one or two inexcusable puns (amino acids for example, are said to be "not named after Idi Amin", which irrelevancy provides the motif for various irrelevant sketches of a Black dictator figure with bubbles coming from his mouth). The only female scientist to appear in the history is Rosalind Franklin (of course), and all cartoon scientists are male. The authors avoid any tricky conceptual problems in what is generally a triumphalist account, and end with a brief look at some of the new ethical issues raised by biotechnology. Recommended, therefore, for biology school students and medics at any level.

Rosenfield, Ziff and van Loon compress Mendel and get to DNA by page 30, and the rest of the book is a very detailed account of modern molecular biology. By page 200 their cartooning capacity has run out and they are reduced to a text postscript on problems of evolution and the role of introns in the causation of cancer. Between pages 30 and 200 there are some recognisable caricatures of the founding fathers (plus Rosalind Franklin) of molecular biology and a detailed pictographic account of key experiments which I would guess are very far from comprehensible to beginners. Apart from Franklin back-to-back with Maurice Wilkins, the only females to appear are some totally irrelevant and offensive soft-porn nudes. A fun book for male chauvinist postgrad molecular geneticists, this one, and a sad comedown for that generally excellent little publishing house, Writers and Readers. Pity. □

This week's contributors

John Little teaches mathematics in a Swindon school.
Donald Michie is professor of machine intelligence at the University of Edinburgh.
Roy Porter is a lecturer in the history of medicine at the Wellcome Institute, London.
Ian Robson is director of observatories and reader of astrophysics at Preston Polytechnic.
Steven Rose is professor of biology at the Open University. He is co-author with Richard Lewontin of the forthcoming Penguin, *Not In Our Genes.*
Paul Simons *is a freelance science writer, and one-time postgraduate student.*

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Scrub up for masochism

TELEVISION

Dennis Hackett

ANY foreigners sharing the reputedly common impression that the British have a strong masochistic streak, would surely have their suspicions confirmed should they study the television schedules over any six-month period. Channels may differ over what is suitable fare in current affairs, drama, entertainment, or sport, but they are one in their belief that we are hooked on medical programmes.

These come thick and fast and in several forms. BBC1's **Medical Express** (1 February) is of the amiable type. You don't feel you should scrub up for it or adjust your political attitudes. It gives tips about this and that, and reassures and cautions. The presentation is chummy: first names and, in this programme, a little fruit, were tossed about.

We watched Barry Norman, he of *Film 84*, being acupunctured to stop him smoking (a progress report will follow); heard from Dr Michael O'Donnell about the decrease in strokes, just who is likely to get them (the unskilled, particularly in the North and Scotland), and of the theory of some Cambridge doctors that eating fruit has made and can make the difference. Dr O'Donnell was tossed some to make the point.

There was also an item about what to do when faced with a road accident; a constructive piece of film about a Derbyshire coalition of the disabled designed to increase their independence; and, lastly, Dr O'Donnell again on measles. It is a good little series and knows what it is doing.

BBC2's **Your Life in Their Hands** began a new series (31 January). This tends to be a scrub-up programme which will be most helpful, because of its concentration on surgical detail and plumbing, to advanced medical students and practising surgeons.

The first programme must have been something of a coup for it concerned a liver transplant performed by Professor Roy Calne and his team at the New Addenbrooke's Hospital, Cambridge. Produced by Henry Campion, it chronicled immense skill and dedication by the professor and his team, immense courage from patient Susan Smith, and evidenced considerable filming technique.

Mrs Smith, who is 37, with, as far as could be predicted, only 18 months to live, plumped for a transplant, which has only a 50 per cent chance of succeeding.

Her first preparation was in vain. It was discovered that the donor liver, which has to be transplanted within eight hours of removal, had, in the fight for life, received blood that would have proved inimical to her.

The second attempt proceeded and we followed it in great detail. Subsequently there were complex and painful setbacks. Mrs Smith was moved from Cambridge to King's College Hospital, London, which specialises in medical care for transplant patients. King's couldn't help, and Mrs Smith returned to Cambridge for further surgery which basically put her back to square one. Happily this operation removed the complications and she was able to return to King's for the follow-up treatment.

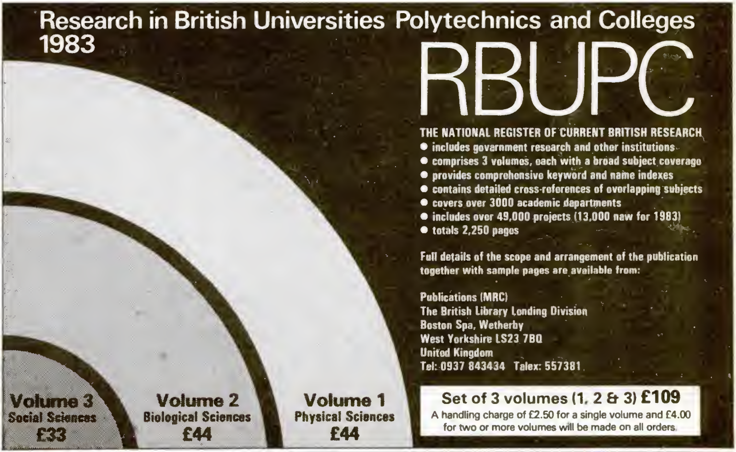
The time scale in all this was some four months. Mrs Smith is now on an optimistic course. She said that it had been harder than she had expected but that she and her husband had been sustained by their Christian faith and by the realisation of the absolute dedication of those trying to help her to life.

It was her dilemma and that of her husband which engaged my attention rather than the complications of fine stitching and surgical technology. Impressive though these are, I feel we get too much of it. I would sooner have heard more from Susan Smith.

We are, after all, more likely to be patients than budding surgeons: television in its admiration for surgical techniques and its own would do well to remember that. □

Patients are more interesting than their treatment

National Institute of Health



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Down on the waterfront

Nancy Heneson visits the aquarium that promises more than a chance to see kissing gouramis. Marketed as entertainment, but with education thrown in, it is a paradise for worshippers of the piscine

WELCOME to Charm City (Baltimore, Maryland, to the uninitiated). When Washington DC was little more than a ghetto built over a swamp, neighbouring Baltimore was a thriving port city, secure in its southern origins and eastern industriousness. But Baltimore deteriorated, and for decades the name "Charm City" smacked of irony.

Now, Baltimore has emerged from the gloom of urban decay. Not only is its harbour enjoying a commercial renaissance, it has also become the setting in which the city presents science to the public. From one end of the inner harbour beckons the Maryland Science Center (*New Scientist*, 15 December, p 824); from the other, a paradise for worshippers of the piscine: the National Aquarium in Baltimore.

Not to be confused with *the* National Aquarium, cleverly hidden in the basement of the Commerce Department in Washington, Baltimore's National Aquarium is a clean-edged, multi-levelled structure, built of concrete, glass, Yankee ingenuity and enterprise in the public interest. The aquarium is a prime example of America's prescription for bringing science museums to life—delight, excite, enthral. Out with ornamental collections, in with thematic exhibits.

This aquarium promises (and delivers) much more than a chance to see kissing gouramis and the mandatory shark or two. "Through a combination of recreation and education," its brochure states, "the aquarium is committed to making known the unity of life through water." Back when the harbour belonged to sailors and wharf rats, none but the whimsical saw in its waters a symbol of unity for the biosphere. Now the miracle of redevelopment has cleansed the harbour and lined it with fancy shops and eateries, the familiar temples to consumption. Situating the aquarium on the waterfront not only makes commercial sense, it brings home a theme.

The theme obviously works. Since its opening in August 1981, the aquarium has edified and entertained more than 3½ million visitors.

The aquarium is not really about fish. It is a journey through the concept of ecosystems, enlivened by displays of the strange and the commonplace inhabitants of those systems. The flow of exhibits parallels the architecture and interior design of the building—as visitors ascend to the upper levels they move schematically from an upland pond to the North Atlantic, on to the Pacific and to an Amazonian rainforest. Then, from the rainforests, a steamy, glass-enclosed pyramid stocked with jungle flora, they descend a central ramp surrounded by a circular tank filled with typical species of an Atlantic coral reef.

The aquarium celebrates diversity in nature, lining an entire wall with backlit photographic portraits of the many shapes and sizes of fishes' fins and eyes. Skeletons of marine vertebrates are slung from the ceilings to divert the visitor's attention, perhaps, from the architecture of the building to the architecture of living things.

Most of the live exhibits are in nooks created by the display itself and lighted panels on each side, which discuss the biology and ecology of the creatures represented. Somehow the text of the panels manages to be copious without being boring, informative without being didactic. Maybe it's the atmosphere: dimly lit common areas punctuated by these bright nooks; subtle but insistent sea sounds emanating from strategically placed speakers. It's mysterious and calm, as one imagines the deep to be. As far from the tank-rock-fish idea of an aquarium as state-of-the-art design permits.

Whatever the secret of its success, the aquarium's educational function is not left to chance. The curator of education, David Pittinger, is proud of his staff of 300 volunteers, who work as exhibit guides, lecturers or teachers of the many courses (coral reef biology is a winner, home aquarium maintenance a dud). Pittinger thinks that education and entertainment can be contained in one experience. The aquarium is marketed as entertainment, a chance to view exotica from the sea, but the visitors get "legitimate education" in the bargain. This is not the case with other types of aquaria, maintains Pittinger. Alluding to the orcan whale that is the star attraction at Seaworld in San Diego, California, he says: "This is no 'Shamu Goes to Washington'." The reference is telling. Seaworld sells itself to the public as a centre for marine mammal research while promoting a circus-like notion of entertainment; the aquarium converted a planned research wing into extra space for the education department.

Ultimately, the visitor decides what to take away from the Baltimore aquarium or any other public exhibition. The aquarium makes no tiresome statements about the importance of human contact with the "natural world" (whatever that means) in this age of technocracy, but somehow the message gets through.

The sheer degree of diversity that characterises the denizens of the Baltimore aquarium, and its emphasis on the complex interactions of biological and physical life, remind its human visitors to reflect a moment before they pop the ten-billionth McDonald's hamburger into their collective mouth. ☐

Photos by Richard Anderson

Morty, the grey seal, has five harbour seals in his outdoor pool to help him entertain the visitors to the aquarium

A clownfish takes refuge in an anemone. One of 11 theme displays, this one shows how animals adapt to survive to life under water

New man in the hot seat

Roger Milne talks with the chairman of the Radioactive Waste Management Advisory Committee

Pete Addis

PROFESSOR PAUL MATTHEWS is very much the image of the theoretical physicist—ever so slightly detached, as if elementary particles are in permanent orbit in his cerebral cortex. During a distinguished career as a physicist, he has worked in Britain and the United States in academic posts: Cambridge and then Princeton, Birmingham University, Rochester University, Imperial College, and most recently Bath University from where he retired last year as vice chancellor. A tall man, courteous but definitely wary when a *New Scientist* photographer and I met him, 64-year-old Matthews has just notched up a month as the new chairman of the Radioactive Waste Management Advisory Committee (RWMAC)—the quango appointed by the government to advise Whitehall on one of the more controversial scientific and environmental issues of the moment.

Public meetings held last year about plans to dump low- and intermediate-level waste at Billingham and Elstow generated hordes of concerned citizenry and anguished reactions. Feelings ran high. They still do. It all seems light years away from the ordered calm of the Royal Society, in the Nash-designed splendour of London's Carlton House Terrace, where we conducted the interview. Paul Matthews seemed genuinely surprised that anyone should want to plumb his views. He remained nervous throughout the interview, relaxing only when I finally pocketed the notebook and pencil.

For a man who once opened the dailies to find himself staring out of a newspaper photograph arm-in-arm with actress Vanessa Redgrave on a CND demonstration, he is clearly unsettled by any glare of media publicity. He admits to more than a few qualms when his appointment, announced last November, coincided with the headline-catching problems of British Nuclear Fuels Limited (BNFL), concerned with radioactive discharge from its Sellafield plant.

Matthews is adamant about the first priority of his committee. "We've got to restore public confidence in Sellafield." But he's under no illusion over the task confronting the nuclear industry and his committee. His personal attitude to BNFL's problems is that last year's well documented accident was "unfortunate" rather than a disaster in the same league as, say, the Aberfan tip collapse of the mid-1960s. Yes, he says, the beach pollution was "regrettable". But, he goes on "there was no significant risk to the general population. No change in the situation as far as sea food is concerned. The only risk is confined to the beaches and the risk of somebody picking up radioactive flotsam."

Matthews accepts that recent problems in Cumbria have dented the nuclear industry's credibility, but he does not believe matters have reached crisis proportions. He doesn't accept that the industry has been either too secretive or too complacent. "If independent bodies have wanted to get information it has always been forthcoming."

Unlike his immediate predecessor, Sir Denys Wilkinson, Matthews has never worked inside the business whose waste disposal strategies he will be monitoring. "I've never had formal links with the industry but I've been interested in nuclear matters for a number of years."

In the past, RWMAC has been criticised for keeping too low a profile and voicing the interests of the nuclear industry, from which a quarter of the committee is drawn. Matthews, while not promising radical changes, is anxious to disown any charge of bias in the stance of the committee. He believes his hand will be strengthened once the committee's current crop of vacancies are filled with an environmentalist, a geologist, an economist and most likely a local authority representative. He stresses the independence of the so-called "lay" members and insists that without the full participation of the nuclear industry representatives "there would be no dialogue".

Over the next three-and-a-half years, the term of his tenure as chairman, he hopes the disposal routes will be established for both low- and medium-level radioactive wastes. And that includes dumping at sea for the first category. The marine route is justifiable technically and scientifically, he emphasises. Politically, of course, dumping at sea is virtually a no-go area. It is clear, though, that the present chairman of RWMAC will not be giving much comfort to environmentalists, nor to unions keen to see the present ban sticking.

Matthews is no stranger to high-level committee work. He has done a three-year stint on the Science and Engineering Research Council's nuclear physics board, and a turn on CERN's scientific policy committee. Colleagues remember him as hard working and keen to reach conclusions.

A past winner of the Rutherford Medal and Prize, his 1963 US-published textbook on quantum mechanics is still in print. His more recent (1971) *Nuclear Apple* is not, however, making him rich beyond the dreams of avarice—though the trickle of royalties suggests that the Japanese are still buying the work.

Matthews plans to divide his time between RWMAC, editing the *Proceedings of the Royal Society* (he was elected a fellow in 1963) and, in his own words "dabbling" in the University of Cambridge's department of applied mathematics and theoretical physics. As a mathematician as well as a physicist it's no surprise to learn that Professor Matthews welcomes current moves to treat risk quantitatively. Tongue in cheek, he adds: "But don't take the numbers too seriously..." □

Cambridge eyewash

Donald Gould finds a health warning that makes the sparks fly

POOR Mr Ken "Was-My-Face-Red" Shooter, who is the doubtless unparagoned Inspector for Technical Subjects in the County of Cambridgeshire. Just after Christmas our Ken sent the following alarming communiqué to the heads of all the colleges and schools in the county in which the gentle and useful art of arc welding is taught.

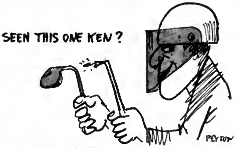
> Dear Colleague,
>
> IMPORTANT SAFETY ALERT
> ELECTRIC ARC WELDING
>
> I would appreciate your calling the following hazard to the attention of all your teachers who may have access to, or teach *Electric Arc Welding*.
>
> A recent incident has uncovered a previously unknown phenonema [*sic*] of serious gravity.
>
> An employee in an Engineering Company flipped open the coloured filter of his face shield to position his welding rod. He inadvertently struck the metal to be welded producing an arc. *The employee was wearing contact lenses.*
>
> On returning home from work, he removed the contact lenses and the cornea of the eye was removed along with the lens. RESULT - PERMANENT BLINDNESS.
>
> The electric arc generates microwaves that instantly dry up the fluid between the eye and the lens, causing the cornea to be bonded to the lens. This trauma is painless and the operator never knows an injury has occurred until removing the contacts.
>
> It neccessarily [*sic*] follows that NO CONTACT LENSES SHOULD BE WORN BY ANYONE WHO IS POTENTIALLY SUBJECT TO AN ELECTRICAL SPARKING SITUATION, eg ELECTRICAL ARC WELDING.
>
> Yours sincerely,
> *K. A. Shooter*
> *Inspector for Technical Subjects,*
> *Design Technology*

Well, well, well and loksamussy, as my Dear Old Dad would frequently exclaim, meaning may the Lord have Mercy on Our Souls. What perturbations and apprehensions must have been aroused within the hearts and minds of the teachers and learners of arc welding in and around the Fens when they realised that they were exposing themselves to "a previously unknown phenomena of serious gravity".

MIGHT BE A GOOD IDEA IF YOU COULD WELD CONTACTS IN
PEYTON

I recognise, of course, that not all votaries of the welder's craft are likely to be kitted out with contact lenses. Indeed, I suspect that the number of certificated and trainee arc operatives so equipped is small, because the vocation is of a kind that would chiefly attract no-nonsense, practical-minded souls, devoid of vanity, who, if in need of an optical crutch, would likely settle for a pair of NHS specs. But even the contact-lens-free majority of honest artisans "potentially subject to an electrical sparking situation" must have been filled with dismay at what the good Ken Shooter had to say.

After all, a powerful surge of killer microwaves, hefty enough to "instantly dry up" all tears, and bond the cornea to its overlying glass or plastic cover, must surely be capable of doing all manner of other mischief to the living flesh. Cataracts, sterility, premature baldness, and insanity are a mere few of the possible horrific consequences of such baneful radiation that will instantly spring to the imaginative scientific mind.



But, of course, and as was soon to be made manifest, the arc welders of Cambridgeshire had been needlessly distressed. Our Ken, in his cautionary circular, had failed to say how he had become aware of the frightening "previously unknown phenonema", and it fell to a Brian Finch, chief safety officer at a welding institute in the county, to put thing straight.

The shock-horror story of the plucked out cornea had been circulating in the bars, corridors and common rooms of the welding fraternity for a decade or more, having first, so they say, appeared in the pages of an American magazine in 1973. Finch and his expert mates had soon established that the tale was a load of old cobblers, and ever since he has laboured often and hard to persuade nervous and credulous colleagues of the fact. "We've had hundreds of phone calls about it," he told the *Cambridge Evening News*. So it seems that Ken, being, I suppose, a generalist in technical affairs, rather than a specialist in welding lore, had come across the myth somewhat late in its career.

Now; I did just wonder how it could come about that a senior and doubtless knowledgeable county council official could issue so startling a notice without checking all his facts. He might, for example, have rung up some friendly neighbourhood quack to discover whether it is remotely possible that a tired welder, home after a hard day's arcing, could casually slip a fingertip under his lids and lift off the fronts of his eyeballs. He might have asked a physicist or an electrical engineer (Cambridge does contain a few) whether welding sparks do generate microwaves which could vaporise tears, and, if so, what would happen to the steam. He might even have asked *himself* whether such an awful self-inflicted injury could be accomplished with careless ease.

Then I thought about Uri Geller, and how some eminent academics, and many a hard-bitten journalist, and even this great journal, paid that spoon-bending spoofer the most serious attention for quite some time. And I reckoned that our Ken was in good company. ☐

Big is not necessarily beautiful

Derek Ager turns his mind to the size of academic science departments

WHO TOLD the University Grants Committee (UGC) that big is beautiful so far as university science departments are concerned? It now seems to be an accepted truth. But is it true? No doubt the big and influential departments have told the UGC that it is true, but are there any quantified data to support the contention?

I spent 18 years in the largest geology department in the country and then moved to be head of one in the small to medium category. I have nothing against the former, which was a splendid department full of splendid people doing splendid work. But when I try to quantify scientific productivity, I find that my present department produces more graduates with about a quarter of the staff. What is more, relationships with students are very much better in the small departments where everyone knows everyone. This can only be to the advantage of the teaching and postgraduate research. Certainly research does not suffer at the expense of teaching.

In the past few years my department has produced a slightly higher publication rate per member of staff compared with the large department; and I mean real papers refereed in respectable journals, not book reviews or obituaries or such-like. Both average about 1.3 papers per year per person. What is more, our small Department of Genetics has achieved a remarkable average of about 4.6 publications per member of staff per annum in recent years. Our Oceanography Department, which is under threat at the moment for the crime of being small, has produced four books and about 88 scientific papers from a staff of six in the past four years. At the same time, they have graduated about 24 students per year and supervised a large number of research students. It is not, of course, possible to make direct comparisons between disciplines. An afternoon's experiment in one cannot be compared with months of field work and resultant laboratory work in another. I say that with feeling!

It is not difficult to see why large departments are not more productive, and this conclusion is not only based on my own experience (in many departments around the world), but also on what I have been told by many others in the universities. In a large department, a sizeable section of the staff separate themselves off as pure researchers and are under no particular pressure to produce results. The teaching load tends to fall heavily on a few willing souls, and a number of others just disappear into the woodwork. In a small department this is not possible. Everyone has to pull his or her weight or it is very quickly noted by the others. No one can rest on his or her laurels, however nobly won. Looking through the lists of staff at all the British departments, in my subject, I find that I know nearly all of them in the small departments, but the large departments include many names that have never penetrated my scientific consciousness.

In my large department, it was only when there was free alcohol available that I met many of my colleagues and their research students. I remember at one of the last sherry parties I attended there, I found myself next to a man whose face I vaguely recognised as a former student. "What are you doing now?" I asked while trying to remember his name. "I've been on the staff here for the last two years," he replied.

Obviously there must be a minimum size for viability, but I feel sure that the figure is very much lower than the ones that have been bandied about recently. Obviously, too, one needs a large department if one has a radio telescope and six mass spectrometers to support, but if the UGC and research councils are going to pursue this policy, they should provide some data to show that there is at least a grain of truth in it. □

Professor Derek Ager is head of the Department of Geology at the University College of Swansea.

The real history of tape recording

Barry Fox investigates the origins of a concert to be held in London this week

FIFTY YEARS ago, a German chemical company, which had grown rich and successful from synthesising dyes, fertilisers, resin, rubber and plastics, turned its attention to something completely different—a strip of plastics film coated with magnetic material for recording sound. That company now calls itself BASF because its original title, Badische Anilin & Soda-Fabrik, hardly rolled smoothly off a non-German tongue.

The switch to BASF, in 1973, was not the company's first change of name. You will not find the original patents on magnetic tape listed under BASF or Badische. They were filed by I. G. Farben, a name which BASF prefers to forget. Farben was the giant empire formed between two world wars by an amalgamation of the three major chemical companies in Germany, Bayer, Hoechst and BASF. It fuelled the German war machine with synthetic oil, rubber, explosives and Zykon B, the poison gas for concentration camps. Farben used slave labour to build its plant in Auschwitz.

The Allies dissolved I. G. Farben in 1945 and the companies involved went back to their original names. What BASF did in Germany was no worse than what Japanese companies, now household names for hifi and video, were doing at the same time in the Far East—or the British chemical industry in Dresden, and the Americans in Vietnam. But the feeling of guilt that oppresses most Germans born since the Second World War has the unfortunate effect of making it difficult for the company to talk freely about a seminal period of magnetic recording history. Audio-tape recording was used in the war years by Hitler to confuse foreign intelligence.

Recently, 350 reels of tape were found in Koblenz. They confirm apocryphal stories because all contain speeches by Hitler recorded during the war. They were broadcast from one city while Hitler was in another. The Allies were confused because they thought they knew where Hitler was, but the broadcasts were not blemished by the characteristic cyclic surface noise of a disc recording. Intelligence officers had not yet learned to recognise the characteristic sound of continuous tape hiss. In any event, it was masked by reception hiss. The BASF archive now has some of these original tapes but it is reluctant to publicise this because of the Hitler content and the fear that young Europeans may make political capital out of the historic tapes.

Another batch of old tapes has also turned up. During the war, a German lorry overturned on a country road, spilling a box of tapes that were later found by local farmers. They had no idea what the stringy material was so they used it to bind tomatoes. Some of these bindings have just come to light and BASF engineers hope they may be able to retrieve snatches of the original sound.

The idea of magnetic recording is almost as old as Edison's cylinder. The Danish engineer Valdemar Poulsen succeeded in recording sound magnetically, by using wire strip at the turn of the century. In the late 1920s a German engineer, Fritz Pfleumer, coated paper tape with iron dust to replace wire or steel strip. But performance was erratic. In 1932 the electronics company AEG Telefunken asked BASF (more accurately Farben) to use its chemical expertise and make something more reliable and durable. In 1934 Farben delivered the first 50 000 metres of tape to AEG and the next year the two companies joined forces to show the world's first working tape recorder or "Magnetophone" at the famous biennial Berlin Radio Show.

BASF

BASF's trial production magnetic tape in 1932 was not so flexible as its modern counterparts

BASF

Sir Thomas Beecham conducts the LPO at BASF's Feierabendhaus in 1936

In November 1936, Sir Thomas Beecham was touring Germany with the London Philharmonic Orchestra (LPO). One of his concerts was in the BASF hall at Ludwigshafen and company engineers taped the performance. Afterwards concerts was in the BASF hall at Ludwigshafen and company engineers taped the performance. Afterwards Beecham listened to the playback, instead of joining 600 guests at a banquet arranged in his honour. The original tapes still exist. This Friday (10 February) the LPO is repeating exactly the same programme live at the Barbican Hall in London, to celebrate magnetic tape's 50th birthday.

The London location for BASF's celebration is appropriate, because the German company owes its existence to a London invention. In the early 19th century the only way to colour silk was with vegetable dye. The natural dyes were so fugitive that sometimes a lady would go out for an evening with a violet ribbon in her hat and come back with a red one. During the Easter vacation of 1856, William Henry Perkin, an 18-year-old student at the Royal College of Chemistry in London attempted to synthesise quinine by oxidising aniline from coal tar. He failed, and was left with a coloured sludge. Instead of throwing it away, he tried using it to dye silk. The silk turned mauve, and stayed mauve. Despite the legal problems of being only a minor, Perkin patented the dye. His father financed production of the dye in a factory at Greenford Green, near Harrow, using coal-tar waste. The textile industry was soon clamouring for synthetic mauveine.

In Germany there were mountains of coal tar waste created as an unwanted byproduct of the coal gas works. German chemists built factories to convert the waste tar into highly profitable dye. By the turn of the century, there were 700 different colours available. Perfumes, flavouring, explosives and saccharin sweetener followed. Today the most striking impression of the BASF chemical factory is that, although it is the size of a small town, there is not a trace of chemical smell in the air.

The British chemical industry complained bitterly that the Germans had robbed it of its coal tar birthright. But Raphael Meldola, president of the Chemical Society, spoke the hard truth at the Royal Institution during a meeting in London to celebrate 50 years of the coal tar industry, and to honour Perkin's presence. "Had our manufacturers adopted the same methods that the Germans have adopted we might have been in a different position today," he told the RI. "Because a certain discovery is made in a particular country, must it for all time remain in that country? We have progressed slowly, but Germany has progressed by leaps and bounds."

Paradoxically, BASF is today finding itself in much the same position. The company invented recording tape and became a household word because of it. But the Japanese are fast decimating the European tape industry with the same tactics that the Germans used to decimate the British coal-tar industry. TDK of Japan has now won more than 30 per cent of the audio-tape market in Britain, after only 10 years in business here. The next generation of audio and video recorders will use magnetic tape coated with a sub-micrometre film of pure metal by vacuum deposition. BASF's pilot plant in operation is under licence to the Japanese company, Matsushita, which invented the process. □

Sixty years of the six pips

Enid Lake on a time-marking anniversary

JOHN REITH, the highly autocratic head of the then newly established British Broadcasting Company, proposed in 1923 to the Astronomer Royal, Sir Frank Dyson, that a time signal should be transmitted regularly into the homes of the nation. Such broadcasts, from the Royal Observatory, Greenwich, would provide, he suggested, not only a useful service to listeners but also would raise the prestige of the observatory.

While this remark showed Reith's perception of the influence exerted already by the embryonic British Broadcasting Company, it was hardly a tactful comment to make to the director of an institution with nearly 250 years of fine scientific work to its credit—much of it carried out under the most stringent financial constraints. Dyson was stung into retorting that Greenwich Observatory's prestige depended on its numerous astronomical achievements, not mere publicity. Having made his point, the Astronomer Royal was quite willing to cooperate in providing a public, nationwide time signal, but there was the usual problem of funds . . . a problem which was settled by the BBC bearing the entire cost of setting up the service, about £150.

The first public time signal, the Greenwich Time Ball, had been set up in 1833 by the then Astronomer Royal, John Pond, for the benefit of mariners, clockmakers and citizens living within sight of the Royal Observatory. His successor, Sir George Airy, had pioneered the use of the rapidly expanding railway telegraph network for distributing Greenwich Time. Charles Shepherd patented his electric clock in 1849 and by August 1852 Airy was using one to disseminate time signals automatically—along the newly installed telegraph line linking the Observatory with Lewisham Station, and so with the rest of Britain. Wireless time signals were introduced in 1904, mainly for navigational purposes, and several specialist time stations (though none of them British) were in operation before the First World War.

Radio stations transmitting to the general public were in their infancy in the early 1920s. The BBC obtained its licence to broadcast on 18 January 1923, and later that same year, in April, moved to new studios in the premises of the Institute of Electrical Engineers (IEE) at Savoy Hill. The BBC invited a member of the IEE, Frank Hope-Jones, an expert on electric clocks, to make a topical broadcast announcing when the clocks would "go forward" for Summer Time. Hope-Jones finished his broadcast by giving a time check from his watch, counting out the last five seconds before 10 pm, and this led to his novel suggestion that the BBC should broadcast a time signal brought by land line direct from Greenwich Observatory.

Reith took up this proposal and within a year, on Tuesday, 5 February 1924, the Astronomer Royal introduced the now famous signal when it was transmitted for the first time at 9.30 pm. The signal, six pips at one second intervals, the last indicating the beginning of the minute, were transmitted to the BBC on the hour, half and quarters from a specially adapted long-case pendulum clock at Greenwich.

The Post Office set up a transmitter at Rugby in 1927 to broadcast Greenwich Mean Time (via landline) for scientific and navigational purposes. The time signals originated from Greenwich until the London blitz in 1940 forced the Time Department to evacuate to Abinger in Surrey. At the end of the war, the observatory itself was relocated to a more suitable site at Herstmonceux in Sussex, the main Time Department eventually was able to rejoin it in 1957.

Over the years, the signal was controlled by Short free-pendulum clocks, quartz crystal clocks, and is now derived from an atomic clock at Herstmonceux which has an accuracy in the order of 1 second in 30 000 years.

Astronomers have used the rotation of the Earth on its axis as the principal method of keeping time. Atomic timekeeping has shown the Earth an unreliable clock because of changes in its rotation rate. Greenwich Mean Time, distributed by the pips, and atomic time differ slightly (but significantly) from each other and occasionally a leap second is required to bring the two together. When required, a seventh pip is transmitted for a leap second. Hope-Jones suggested five pips, Dyson added the sixth (now a slightly longer beep) and the seventh was brought into being from 1 January 1972.

Enid Lake edits *Popular Astronomy*.

Thistle diary

More pages from Tam Dalyell's parliamentary notebook

PETER (You - Wanna - Buy - a - Wind - scale?) Walker has been raising the ire of parliamentary members. Many MPs believe that the placing of British Nuclear Fuels Limited (BNFL) in private hands is a dangerous brand of madness that only a bunch of Dr Strangeloves would advocate. But MPs are also incensed that the Secretary of State for Energy is abdicating his ministerial responsibility on the floor of the House. Instead of answering members questions, he is referring them to the chairman of BNFL.

Brian Sedgemore (Hackney South and Shoreditch) has gone as far as to suggest that BNFL is "clearly out of control if it can ride roughshod over ministers, or so frighten ministers that they no longer carry out their duties to parliament." While some of his questions may have been technical, they were all of political import. One of them related to the failure of BNFL and the government to see through a recommended safeguard for the public despite having had seven years or so to do it (the appointment of an independent health expert to analyse BNFL's health statistics). Another question concerned information on BNFL's own survey of the incidence of cancer among its workers. Mr Walker should tell us the answers to these questions himself. The doctrine of ministerial responsibility is important to the continuance of our democratic process.

* * *

LIKE OLD SOLDIERS, former MPs tend just to fade away—or at least to make no further contribution to topics on which they were often highly regarded when they sat on the green benches of the Commons. Arthur Palmer, who retired from Bristol Central at the last election, has just produced a pungently argued pamphlet *Nuclear Power—The Reason Why*, published by the Electrical Power Engineers' Association.

Because dynamite can be used for safe-breaking, says Palmer, it does not follow that it should never be used for quarrying. Similarly, nuclear power and commercial power stations should not be confused with nuclear missiles.

Palmer tells the story in his pamphlet of how, during the First World War and the Bolshevik Revolution, it was reported to the British government that mutinous sailors of their allies had seized an admiral on a Russian battleship and thrown him into the furnaces. Whereupon, a Whitehall Cabinet minister with a practical turn of mind asked if anyone knew the calorific value of an admiral! For Palmer, this grim tale illustrates the outlook of power supply engineers: they have not turned to the possibilities of the nuclear steam boiler for the fun of it. The power supply industry would gladly burn seaweed if it were the most economic and feasible way of making electricity in the quantities required.

Palmer's tract is technically correct and a good read. It is a great pity that he cannot continue his lifelong, and often rather lonely, interest in matters scientific. He was a much revered chairman of the Commons Select Committee on Science and Technology during 1966-70, and 1974-79, and a member of the Lords Select Committee. He would be a valuable addition to the House of Lords. It would be appropriate if he were to fill the berth left vacant by the late and much lamented Christopher Hinton, the famous CEGB chairman, who became Lord Hinton of Bankside OM. Hinton gave me much sound advice during my first 20 years in the Commons.

* * *

THIS ONE SMELLS LIKE GREENS - THEY'LL NEVER PUT THAT IN THEIR MOUTHS!
SCENTED ERASERS
Austin

WHAT IS THE LATEST PERIL? Why, scented products! Greville Janner has asked the Trade Minister whether, in view of the dangers to children of swallowing scented products such as rubbers and pens, he will ban the sale of these products, pending full investigation, and institute an inquiry. The Minister of State, Alec Fletcher, claims he is urgently considering what action might be taken to deal with any likely suffocation risk, particularly to young children, from scented articles, such as erasers. Now, I'd like to know what scientific genius devised the scenting of rubber in the first place?

* * *

IN AN AGE when the press highlights every dramatic surgical spectacular, it is inevitable that expectations should be raised in any family where a transplant is required. Thus when Professor Roy Calne and his team at Addenbrooke's Hospital are seen to have performed a liver transplant on a two-year-old child, it is not surprising that many families wonder whether the same cannot be done to ease their affliication. One of the limiting factors is invariably money. The annual cost of a kidney dialysis machine is now on average £16 000—such money is becoming increasingly difficult to find what with the cuts that the National Health Service is suffering.

The provisional annual total of kidney transplants in Britain is 1160. Yet there are over 2400 patients awaiting transplants. It is all very well for the government to say that it is launching a new publicity campaign to increase public awareness of the need for transplantation, and to encourage the widest use of the organ donor card. The truth is that in the absence of an amendment to the Human Tissue Act to permit hospital authorities to take the kidneys from anyone, other than those who have opted out during their life time, there will never be enough matching tissues. Nor is a sufficient number of kidney machines available for dialysis while patients wait for tissues suitable for transplant. Many patients, often with the prospect of useful working years in front of them, could be saved but for the shortage of cash for such dialysis units. □

ENIGMA

No. 249

Championship double

by Susan Denham

WE ARE drawing up plans for our local club's annual tennis championship for the next few years. The championship is held for a week in spring and consists of a group of members each playing each of the others just once. We are planning for increased numbers of participants and so we asked the groundsman how many matches the courts could cope with in this and next year's championships. He gave his figure for this year and said that with the planned club extensions we could cope with twice that figure next year.

The chairman reacted that both those figures were inappropriate as neither equalled a possible "championship total" number of matches, that is to say no matter how many players took part in a championship the number of matches needed could not equal either of the groundsman's estimates.

So the chairman interpreted these figures by assuming that the number of matches played this year and next would be the lowest "championship totals" above each of the groundsman's estimates. He then announced his revised estimates for this year's and next year's matches and, by coincidence, *his* figure for next year is twice his figure for this year.

One might be led to believe that the year after next will see three times the number of matches which the chairman predicts for this year; but that is impossible. But it could happen that the number of matches in the championship the year after next is three times the groundsman's estimate for this year.

How many matches did the groundsman estimate for this year?

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 23 February, 1984. Please send entries to Enigma No 249, New Scientist, *Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 246, "League of Five", was P. F. Crook of Hickling, Norfolk.*

Answer to Enigma 246

League of five

A	*v*	*B*	4-0	*B*	*v*	*D*	0-0
A	*v*	*C*	0-2	*C*	*v*	*D*	2-3
A	*v*	*D*	0-1	*D*	*v*	*E*	3-3

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Robot arms: products for the disabled identified by their own organisations: energy-monitoring and energy-saving devices identified by tenants: computer software to make the expertise of specialists available to ordinary GPs and patients; these are some of the projects already in the product bank, before the first four networks are even fully under way.

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LETTERS

Home truths

I agree with the comment made by Brian Mower, Director of Information, Home Office (Letters, 26 January, p 50), when he says that "It really is a pity this [checking of passports by computer] cannot be written about without invoking 1984 demonology".

However, I think that we should all, for the time being, continue to question the intentions of any body which feels a need to publish "information" of the quality contained in the pamphlet *Civil Defence; why we need it*, prepared by the Central Office of Information for the Home Office and the Scottish Home and Health Department.

Dr Richard Johnson
Bucksburn
Aberdeen

Nuclear cluster

The suggestion in the *BMJ*, in November 1983, repeated in *New Scientist* (26 January p 7), that an unusual cluster of Down's syndrome babies born to Irish mothers who went to school in Dundalk could be connected with the Windscale fire of 1957 is unbelievable on at least two counts.

First, if indeed activities released from Windscale were such as to cause genetic disorders in Irish mothers, the pattern of abnormalities would have been one of widespread excess incidences of a number of cancers and genetic disorders, not a single cluster of.one adverse effect limited to one boarding school. Secondly, if indeed radiation doses in Ireland (which was not in the path of the major release) were high enough to cause genetic abnormalities, then the radiation doses to the population of West Cumbria (parts of which were in the immediate path of the release) would have been thousands of times higher than those actually observed and excess incidences of cancers and genetic disorders would also be correspondingly high.

In fact, the radiation doses to the Cumbrian population can be relatively well estimated and evidence for increased incidence of cancer locally is dubious or non-existent. *New Scientist* mentions that all of the mothers had suffered an illness similar to influenza in October 1957. Since I am ignorant on the subject, I will not speculate as to whether influenza or similar viral infection might be sufficient cause for the observed abnormalities. I suggest that Professor Blackrith and the Dublin MDs would be well advised to show similar restraint when considering radiation effects.

Terry Sumner
Wantage
Oxfordshire

Building bridges

The article by Mick Hamer on the Severn Bridge mentioned the destruction of a model bridge in a wind tunnel at the National Physical Laboratory (12 January, p 8). In the context of the paragraph, this mention may be misconstrued by some of your readers to mean that there could be a link between the destruction of the model by wind and the possible destruction of the Severn Bridge by wind. Let me allay their fears.

The model in question represented a section of the deck of a proposed truss-stiffened bridge. It was undergoing tests in the wind tunnel to examine its dynamic response to wind and was suspended from the wind-tunnel roof by springs and cable links. The cable links snapped and the model broke away. There is, then, no connection whatsoever between the event and any possible behaviour of the Severn Bridge.

It is, however, an ill wind that blows no good. The model was made of wood and passed through four sets of turning vanes and the propeller at least once and was smashed to pulp before the wind died down. Obviously a new model had to be made before the tests could be continued. At the request of the design engineers, advantage was taken of the delay to develop the aerodynamically stable section for a closed box-girder bridge (no mean task at that time) that was finally accepted for the Severn Bridge.

D. E. Walshe
Applied Fluid Mechanics Division
NMI Ltd
Teddington, Middlesex

IF YOU DONT GET RIGHT OVER THERE'S A REFUND
TOLL BOOTH
Austin

On-line postgrads

We support Simpson's and Earthy's call for ready access to information on postgraduate student research (Letters, 19 January, p 45).

RBUPC (*Research in British Universities, Polytechnics and Colleges*) and Aslib's *Index to Theses* together provide a printed record of work in progress and completed research for higher degrees in the UK. Mounted as computer searchable databases on the British Library's Blaise information retrieval service, they would help to alleviate the problems involved in retrieving this type of material. An added advantage of using the existing Blaise system for this purpose lies in its facility for automatically switching retrieved references to the British Library Lending Division's interlibrary loan requests. The BLLD's holdings of thesis literature are by far the most extensive in Britain.

A publicly available on-line employment register of British postgraduate students may be less easy to achieve although we understand that DES has sponsored a feasibility study to develop a computer-aided career guidance system which will include employment opportunities.

Carolyn Rowlinson
M. J. Snell
University of Stirling

ISR physics

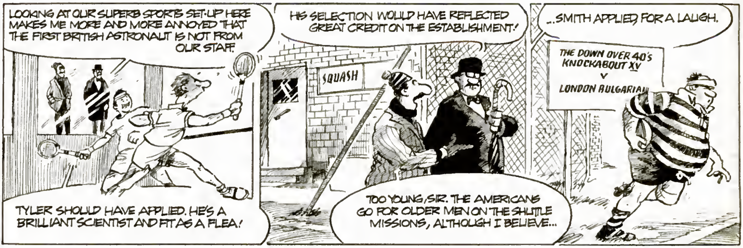
Concerning the excellent article "Protons in collision" (8 December, p 743), I disagree with the statement that the ISR missed the discovery of the J/ψ and Y particles because of a "strong element of conservatism in the early experiments", in contrast with the recent "more adventurous approach" which has rewarded CERN with discovery of the W and Z particles.

The basic difference between those early ISR experiments and the recent experiments at the CERN $p\bar{p}$ collider is that in the case of the W and Z particles we knew exactly what to look for and all relevant quantities, such as even rates, mass values and backgrounds, turned out to agree with the theoretical predictions. In addition, the signal-to-noise ratio was extremely favourable.

On the contrary, in the early ISR experiments we did not know what to look for and backgrounds turned out to be much higher than predicted. In our paper "A search for electron pairs at the CERN ISR" (*Physics Letters* 48B(1974) 377) we said: "... five events ... were found to satisfy all requirements ... The pair masses were distributed above a threshold of 3·1 GeV_2/c^2." It is amusing to note that the mass value of the J/ψ particle is 3·097 GeV/c^2. The reason we did not set the threshold at a lower value was that we found a very high rate of pairs of π^0-mesons with high transverse momentum which saturated our data acquisition system. This background was unpredicted.

GRIMBLEDON DOWN

Bill Tidy


LOOKING AT OUR SUPERB SPORTS SET-UP HERE MAKES ME MORE AND MORE ANNOYED THAT THE FIRST BRITISH ASTRONAUT IS NOT FROM OUR STAFF.
TYLER SHOULD HAVE APPLIED. HE'S A BRILLIANT SCIENTIST AND FIT AS A FLEA!
HIS SELECTION WOULD HAVE REFLECTED GREAT CREDIT ON THE ESTABLISHMENT!
SQUASH
TOO YOUNG, SIR. THE AMERICANS GO FOR OLDER MEN ON THE SHUTTLE MISSIONS, ALTHOUGH I BELIEVE...
...SMITH APPLIED FOR A LAUGH.
THE DOWN OVER 40's KNOCKABOUT XV
V
LONDON BULGARIA

It is now interpreted as the result of hard scattering of proton constituents. This phenomenon turned out to be one of the main ISR discoveries.

The history of the Y particle is rather different. This particle was observed at the ISR only by the end of 1977, when the ISR had reached a collision rate high enough (about one order of magnitude higher than the design value) to produce it at a reasonable rate. Even so, experiments were able to detect only about 50 Y particles per year of ISR operation in a fully dedicated mode. At the Fermilab machine, with a collision rate 10 000 times higher, 500 Y particles were observed in May 1977 in two weeks of running time, by an apparatus which had an acceptance very similar to that of ISR experiments.

The approach that led to the recent discovery of the W and Z particles at CERN was adventurous only for what concerns the accelerator complex itself (many people had considered the transformation of the SPS into a $p\bar{p}$ collider as a very risky project with little chance of success). On the contrary, the two experiments which observed the W and Z particles were designed and built following conservative ideas. I doubt that these experiments would have discovered the J/ψ particle, had they been running at the ISR.

Luigi DiLella
CERN, Geneva

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Rally round

I was very saddened to read Johnny Muirhead-Thomson's cynical view of Operation Drake/Raleigh (26 January, p 2).

I write as one of the "young hopefuls" Muirhead-Thomson refers to. He seems to give the impression that thousands of people have been attracted to the operations merely on the overwhelming urge to take part in a major scientific survey.

STUFF YOUR NOBEL PRIZE - I WANT A DUKE OF EDINBURGH'S AWARD!
Austin

This may be the case in a few instances, but for myself (and I think many thousands of others), the reason for applying is to take part in challenging projects in hostile environments, not necessarily to discover things about the natural world, but to explore myself, to find out my capabilities and where my limitations lie.

I think Muirhead-Thomson is wrong to view the operation merely in a scientific light. He should look at the project as a whole and not just criticise one aspect of it.

Peter Hughes
Sutton Coldfield
West Midlands

Surrounded in doubt

There were some errors in Professor P. B. Fellgett's letter to you on Ambisonics and the British Technology Group (Letters, 26 January, p 50).

Professor Fellgett says that he has no evidence to confirm BTG's reported claim to have spent more than £50 000 (presumably a misprint for £500 000) on the furtherance of Ambisonics. He must be aware however that he and his associates receive regular statements of income and expenditure, the last of which related to the period to 31 December 1982. The total of expenditure shown in that statement was £387 947·26. Expenditure has increased since that time and the current total is close to £500 000.

He mentions also that royalty income on Ambisonics has fallen to exactly zero and relates this to a claim that "BTG withdrew cooperation from us" two years ago. As far as we can see there is no connection between variations in royalty income and any cooperation we may or may not have had from Professor Fellgett during that period. Most of the income to date has been earned by one licence and it so happens that the licensee in question has concentrated on a new product, released only recently, during that period.

Professor Fellgett refers to the Manfred Fox Report. If he has seen that report he will know that it is based on a very small sample of our cases which were not a random selection and that the conclusions presented in it cannot be stretched into generalisations. Neither of the other two reports to which he refers is concerned with BTG to any significant extent.

We share Professor Fellgett's disappointment that Ambisonics has not yet been adopted by the audio industry in any significant way but this is not through any lack of commitment on our part. Development has been supported to a very significant extent, the technology has been given wide publicity including broadcasts by the BBC, there are available more than 100 records in Ambisonic format, decoders are available off-the-shelf from Minim and other suppliers and we have here at our premises at the Elephant and Castle demonstration equipment which is in regular use.

A number of inventors are involved in the Ambisonic technology and a diversity of views on exploitation can only be reconciled by a degree of mature cooperation from all concerned. Needless to say the task of transferring the technology to industry can only be made much more difficult if our efforts to produce a concerted approach to the market are constantly undermined.

Peter Tanner
Technology Transfer Division
British Technology Group
London SE1

Old mountains

Although replies by authors to reviews are not usual, things are different when criticisms are based on gross numerical errors, as is the case with the review of my book *The Earth and its Mountains* by Keith Runcorn (8 September, p 706).

First, an error of dynamics perpetrated back in 1920 and repeated in all six editions of *The Earth* passed unnoticed till discovered by the writer in the early 1970s. When put right, one of the consequences was to bring to fight a further effective couple acting on the Earth owing to its contraction, over and above the already recognised lunar and solar couples. Moreover the correct theory shows that this intrinsic couple is essentially greater than the solar couple, and may even be about twice as great. Thus, to describe it as a *minor lacuna*, as Runcorn does, is utterly absurd, while what he extols as "the classical theory" is not a "theory" at all but simply a series of errors.

Secondly, the most reliable ancient-eclipse data, which cover about 3000 years, when used with the correct theory enable the rate at which the Earth is contracting to be found. On the other hand, the average rate of contraction over the last 3000 *million* years can be derived on the phase-change hypothesis for the nature of the liquid core (which is quite unrelated to eclipses), and this yields a value in extremely close agreement with that obtained from the ancient-eclipse data.

Thirdly, as to priority, Urey in *The Planets* (1952) suggested that sinking of iron might be causing the Earth to contract. But the equations he set down can readily be shown to be hopelessly incorrect. For if any reasonable values of the accelerations and couples are inserted, the two sides show disparities by factors of the order of 10^{40}. Urey did not, indeed could not, make any calculations from such equations, and did not find a rate of contraction, nor any values of the lunar and solar couples. Thus Runcorn taking it on himself to assign priority for the correct theory to Urey in 1952 is without foundation.

R. A. Lyttleton
Institute of Astronomy
University of Cambridge

Page boy

I wish to complain about the change in pagination of *New Scientist* from numbering within each volume to numbering within each issue, as the result of this is that it is no longer possible to refer to an article simply by volume and page number. This then results in a longer reference, as the issue number has to be included, and greatly increases the possibility of mistakes and confusion between different issues. In my opinion, this is a backward step and should be rectified as soon as possible.

J. A. A. Johnson
Tonbridge, Kent

Echoes of TV

Barry Fox (Technology, 12 January, p 22) gives a very lucid account of current moves towards stereo sound with television. The BBC has been distributing sound to television transmitters by the Sound-in-Syncs method for over 10 years, an investment which has paid off very handsomely in the saving of separate sound line costs. We have not really been keeping "tactfully quiet" about the problem of dual-channel sound, but have been busy with the design of a new form of Sound-in-Syncs for this purpose.

The new equipment will accommodate two channels for stereo or dual language sound and incorporates the latest advances in digital sound coding on our NICAM 3 system. The development has reached the stage of tests using prototype equipment over practical circuits. We shall, therefore, be able to move into stereo working at least as easily as other broadcasters.

T. B. McCrirrick
Director of Engineering
BBC, London

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Closing date for applications: 2 March, 1984.

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Technician— R & D Department

(BPL/RD/T4)

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Technician— Analytical Chemistry Section

(BPL/QC/1)

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Application forms and job descriptions are available from Mr B. D. Taylor, Blood Products Laboratory, Dagger Lane, Elstree, Herts.Telephone 01 953 6191. Please quote appropriate reference. Closing date for application: 24 February 1984.

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For further information, please contact Mr B. Bywaters, on 01-672 1255, Ext 4091.

Application forms and job descriptions are available from Mr B. Sorrell, Personnel Officer, St George's Hospital, Blackshaw Road, Tooting SW17 0QT. Tel: 01-672 1255, Ext 4121.

Closing date for receipt of applications, 24 February, 1984.

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THE CITY UNIVERSITY

Department of Chemistry

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To apply please contact Ms Jane Cameron, Personnel Recruitment Assistant, The City University, Northampton Square, London EC1V 0HB. Tel 01-250 1107 (24 hour ansaphone). Closing date for receipt of applications 24 February, 1984.

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Research Chemists – Inhalation Products

Glaxo is internationally renowned for its aerosol products, Ventolin, Becotide and Beconase. We intend to maintain our lead in this area with important new products, some of which are already in their advanced stages.

We now wish to make two new appointments to our Aerosol Development Unit, a multi-disciplinary team which plays a key role in bringing new inhalation products to the market place and supporting existing products.

Physical Chemist *up to £15,500**

We wish to appoint a physical chemist to be responsible for defining the physico-chemical requirements of product formulation and manufacturing processes. You will carry out fundamental investigations to establish the underlying scientific principles governing drug particle stability in aerosol systems, in particular the interaction of drug particles with aerosol components. Your recommendations will have an impact on product and manufacturing specifications.

You should be a graduate with at least 2 years' experience in the areas of surface and colloid chemistry, with the knowledge and ability to provide in-depth expertise in this field. *The initial salary range for this position will be £8,700 - £15,500 inclusive of all allowances. Ref. PC1.

Polymer Chemist *£8,700 - £12,050**

We seek a graduate with practical experience in the field of rubber and polymer technology. You will undertake research and development work to determine the influence of polymer type and quality on the performance and stability of aerosol products, and play an important role in defining manufacturing standards and procedures. *The initial salary range is as quoted above inclusive of all allowances. Ref. PC2.

Both positions call for the ability to communicate effectively with colleagues of varying disciplines within the research and manufacturing companies and in outside organisations.

Starting salaries will be in the ranges quoted and will depend upon experience. Our excellent benefits package includes non-contributory pension and life assurance and participation in Glaxo Group profitability. Generous relocation assistance will be available if appropriate.

Please write or telephone for an application form to Dr. D. J. Humphreys, Senior Personnel Officer, Glaxo Group Research Ltd., Ware, Herts. SG12 0DJ. Tel: Ware (0920) 3993, quoting the appropriate reference number.

Glaxo ***Group Research Ltd.***

BRITISH LEATHER MANUFACTURES RESEARCH ASSOCIATION

Openings of interest to graduates for inter-disciplinary research relating to improving the performance of leather.

A. Applications of optical and electron microscopy to investigate aspects of fibre science relating the influence of industrial processes on the structure and performance of leather
Probable discipline, biology, microscopy, materials science.

B Projects relating to the stabilisation of collagen by reaction with transition metal complexes. Experience in the use of X-ray techniques may be useful
Possible disciplines, co-ordination chemistry, physics, materials science.

For both posts applicants should have an enquiring mind, be willing to work in both the laboratory and in member tanneries. They will probably have 2-5 years experience and must be able to prepare written reports in good English.

Commencing salary within range £5050–£6880 plus excellent pension package

Write sending CV and a statement indicating why the particular position interests you, and what you can offer to:

Director
BLMRA
Kings Park Road
Moulton Park
Northampton NN3 1JD

INTELLECTUAL PROPERTY

We are a firm of solicitors and wish to recruit a science graduate who is either qualified or prepared to qualify as a solicitor, for a position in our intellectual property department involving litigation and contractual matters with considerable technical content. Some previous knowledge of patent law would be an added bonus.

The right applicant might well be a chemistry graduate, although those with experience in other disciplines relevant to our clients in industry could be equally suitable.

If appropriate, we would be willing to help support the successful applicant through his period of qualification as a solicitor.

Please send details to Mrs V. Farrants, Partnership Secretary

McKenna & Co

INVERESK HOUSE, 1 ALDWYCH, LONDON, WC2R 0HF

Progressive Careers in the

Pharmaceutical Industry

If you are a Life Science Graduate aged 24-30 and are looking for a rewarding and challenging career we have many opportunities in:

1. **MEDICAL SALES**
   (Throughout the UK)
2. **CLINICAL TRIALS**
   (Experienced)
3. **MEDICAL INFORMATION**
   (Drug Registration—expd)

For full details and a local interview phone

01-405 0725 or 01-831 6471

Scientific Staff Consultants,
50 Lincoln's Inn Fields,
London WC2

Information Specialist/ Information Officer

The Research Department of ICI's Plant Protection Division requires an Information Officer to work with one of our exploratory research teams. A significant additional part of the job (up to 50%) involves the development of new information services.

Your work will involve you in the construction and implementation of programmes for training scientific staff to search selected ICI and public databases.

You may also be involved in maintaining the quality of certain ICI databases, and in exploring opportunities for the construction of personal bibliographic computer files. You will be working alongside four colleague information officers on these developments, each working in their own Research Team but you should be capable of taking immediate overall responsibility for some issues.

As Information Officer you will be expected to become a full member of a research team, and sufficiently conversant with its objectives to apply your own judgement to required searches and information compilation.

You must be familiar with searching chemical structure and bibiographic databases and a knowledge of patent information retrieval would be an advantage. Candidates who are capable of intensive analysis of chemical patents in support of patent agents will be preferred.

Starting salary will depend on experience and level of responsibility and could be up to approximately £12 000 pa. Other fringe benefits include membership of a profit sharing scheme and pension fund.

Jealott's Hill Research Station is located in pleasant surroundings between Bracknell and Maidenhead. There is a staff restaurant, recreation club and shop on site.

Candidates should apply no later than 2nd March, to the address below, giving a cv covering details of their career to date with all relevant experience. They should also indicate why they are particularly interested in this job and any other special skills which might aid its development.

Personnel Department, ICI Plant Protection Division, Jealott's Hill Research Station, Bracknell, Berkshire.

Please quote reference: 84/CDST.

ICI Plant Protection Division

Senior Analyst Quality Control

We have a vacancy for a Senior Analyst in our Quality Control Department which is responsible for maintaining the high standards of every stage in the research and manufacture of drugs.

Candidates should either be graduates with several years' experience in analytical chemistry, preferably in the pharmaceutical industry, or new PhD's with some analytical experience as part of their post-graduate studies. The person appointed would be involved in analytical development on new research compounds.

Conditions of Service are excellent and include a Christmas Award, 23 days' annual holiday, free life assurance and BUPA membership, subsidised restaurant and contributory pension scheme.

Please send curriculum vitae to Mrs M L Clewley, Personnel Officer, or telephone Mrs D Turner, Welwyn Garden 28128, extension 2129, for an application form.

Roche Products Limited, P O Box 8, Welwyn Garden City, Herts, AL7 3AY.

ROCHE

SOUTH MANCHESTER HEALTH AUTHORITY

Christie Hospital and Holt Radium Institute

Paterson Laboratories

A vacancy exists at

POSTDOCTORAL LEVEL

within a group devoted to the study of the epithelial cells of a variety of tissues. The interests of the group centre on the cellular organisation of proliferation in a wide range of surface epithelia (skin, oral mucosa and gastrointestinal tract), the mechanisms involved in the control of cell proliferation and differentiation and the malfunction of these controls that result in cancer and other proliferative disorders. We are particularly concerned in bringing new scientific interests into the group and add to the wide-ranging approaches that are currently used. Fields of particular interest include epithelial cell culture, flow cytometry, monoclonal antibodies and molecular biology. The successful candidate would be able to develop his own area of study within the overall framework and under the general guidance of Dr C. S. Potten the group leader. Potential projects could include the use of epidermal cultures to analyse control factors, the identification of early differentiation events in epithelial tissues and their relationship to carcinogen target cells.

The work is supported by grants from the Cancer Research Campaign and the position would be tenable for three years with the possibility of renewal.

Applications should be made to Dr C. S. Potten, The Paterson Laboratories, Christie Hospital and Holt Radium Institute, Winslow Road, Manchester M20 9BX, and include a curriculum vitae, the names of two academic referees and outline of interests in connection with the work described above.

UNIVERSITY OF BIRMINGHAM

Department of Chemical Engineering

PROJECT COORDINATOR
(Post Doctoral Research Fellow)

to work in the area of
Heat Transfer and Natural Convection

Applications are invited for the above post. The work involves experimental and theoretical fundamental studies in the field of buoyancy driven convection in complex geometries with novel fluids. The work will be carried out in collaboration with the Atomic Energy Research Establishment at Harwell. All of the experimental work and much of the theoretical work will be done at AERE Harwell. The post will also involve coordination of the research effort of the University team located at Harwell.

Candidates should possess a good honours degree in one of the engineering disciplines (preferably mechanical or chemical), and have carried out postgraduate work in the fluid mechanics or heat transfer area. A good experimental background is also desirable.

Post tenable for up to three years. Salary scale £7190-£11 615 plus superannuation.

For further particulars, telephone 021-472 1301, ext 2559, quoting Ref T1.

No formal application form. Three copies of application, including full curriculum vitae and naming three referees to Assistant Registrar (Science and Engineering), PO Box 363, Birmingham B15 2TT, by 24 February, 1984.

The Royal Navy is looking for engineering or science graduates to work at the sharp end.

Since you'll be responsible for equipping ratings and Officers with the expertise needed to handle high technology, it's a very sharp end indeed.

The Royal Navy has some of the most advanced technology in Britain. It'll be your task to make sure we get maximum value from it. Not surprisingly, we're looking for talented people. Your job is entitled Instructor Officer but there's much more to it than teaching.

Of course, your most important task will be to provide the Navy with the training expertise that it needs at all levels up to post-graduate, but you can diversify. For example, with a science background you could well find yourself being trained to provide the Navy with oceanographic and meteorological forecasts ashore and afloat. Or you could be selected for computer systems training and eventually be teaching and working on advanced computer systems.

As an Officer you will also have an important management role, and be involved in organising the social and sporting life of the Navy. We'll also ask you to take charge of the general education of serving Officers and men. An Instructor Officer's job is a vital one and a starting salary of up to £11,298 will show you how much importance we put on it.

We'll give you plenty of opportunities to enhance your professional qualifications and experience including post-graduate courses and research. So if you want to make the most of your Engineering or Science qualifications, and you're not looking for a 9-5 job, talk to us. Similar opportunities exist for women who, as WRNS Officers, may serve as Instructor Officers. You should have a degree in Engineering (Electronic, Electrical or Mechanical), Physics, Maths or Computer Sciences. You must be a UK resident, ideally 28 or under (25 for women).

You don't need to be a teacher, we'll teach you. For more information, write to: Lt Cdr A. J. Prosser, BSc, RN, Dept. 298, Old Admiralty Building, Spring Gardens, London SW1A 2BE.

ROYAL NAVY OFFICER

Chemical Analysts

£7000-£8000 + Shift Allowance **Enfield, Middx**

The company is a leading pharmaceutical manufacturer and major supplier to the NHS.

Successful applicants will provide a quality assurance service throughout the factory, which operates on a 24-hour continuous process basis.

Candidates ideally aged 21-40 will have an HNC/BSc Chemistry qualification, supported by practical analytical experience.

Contracts are initially for a 12 months period with possible permanent appointments to follow. Basic salary will be within the range £7000-£8000 plus a shift pay allowance of approximately £3000.

Write with full cv to
Tony Culpin, PER,
4/5 Grosvenor Place,
London SW1X 7SB

PER Executive Selection

ROBOT SENSOR ENGINEERING

META MACHINES LTD

Meta Machines Ltd. is a recently established robot system company with a leading position in vision guidance of industrial robots. The company's first product is based on research completed by members of the Oxford University Robotics Group who now form the core of Meta Machines Ltd. The company is substantially funded and is starting several advanced projects in the area of robot sensors and control. As a result, many challenging opportunities for employment currently exist including:

VISION AND CONTROL RESEARCH SCIENTIST
PRODUCTION SOFTWARE MANAGER
APPLICATION DEVELOPMENT ENGINEERS
ELECTRONIC DESIGN ENGINEERS
JUNIOR SOFTWARE/ELECTRONICS ENGINEERS and TECHNICIANS

An exceptional renumeration package has been prepared for the outstanding qualified applicants. For further particulars of these positions please write to:

P. G. Davey and E. T. Hudson
Meta Machines Ltd.
19 Parks Road
Oxford OX1 3PJ

TRANSLATORS (Russian to English). Publisher of major Soviet scientific and technical research journals in English translation requires qualified translators in the following areas: electrical engineering, energy technology, aeronautics, machine sciences, superard materials, friction and wear. Applicants must have a technical background in the field of translation. Ongoing assignments available. Application with curriculum vitae to: Box D787 NEW SCIENTIST.

TRANSLATOR/EDITOR

We are a leading translation company with over 25 years' experience in the pharmaco-medical field. We need to increase our output capacity and are looking for a person with suitable qualifications and/or experience, English mother tongue and sound knowledge of German to join our team, working in an informal and stimulating environment. The work involves processing translations in all branches of medicine and pharmacology, including research reports, manufacturing specifications and published literature. Salary according to qualifications and experience, subject to annual review, plus sundry benefits. Apply in writing to:

Dr A. M. A. Mincer, Chief Editor
AD-EX (TRANSLATIONS) LTD
P.O. BOX 428, 296 KINGSTON ROAD, LONDON SW20 8LZ

NORTHUMBERLAND WILDLIFE TRUST

CONSERVATION LIAISON OFFICER

Applications are invited for the above vacancy from graduates. Salary £5000-£5500 depending on experience. The appointment will be for 18 months in the first instance to complete a three-year contract.

For full details send a large SAE to The Hon Secretary, Northumberland Wildlife Trust, Hancock Museum, Newcastle upon Tyne NE2 4PT.

Systems Engineers

Here at British Aerospace Dynamics Group in Stevenage we are proud of our record of achievements in the field of sophisticated Guided Weapon Systems. Upon this record of success we are building for the future. Linked with our order-books, which stretch well into the 1990's, the Company has established a small team of Systems Engineers to develop a new air defence system using the latest design to cost techniques.

Suitable candidates will, ideally, be in the age range 23-38, qualified to degree standard in Applied Physics, Computer Science, Mathematics, Electrical/ Electronic, Control or Aeronautical Engineering.

Previous experience in one or more of the following areas is desired but not essential:–

- Mathematical modelling.
- Performance analysis of complex control systems.
- Sensor performance (Radar, T.V. and Laser).
- Real time processing.
- Trials definition and analysis.

Where necessary, on the job training can be given but applicants must be able to demonstrate a basic understanding and enthusiasm for systems engineering.

We can offer competitive salaries, commensurate with the level of appointment, together with conditions of service appropriate to a major engineering organisation. Where appropriate, a generous relocation package will be made available to selected candidates.

If you feel that you can meet the challenge that these positions offer, please write or telephone for an application form to:– Mr. N. J. Griffiths (Ref. C529A) Personnel & Training Department, British Aerospace PLC, Dynamics Group, P.O. Box 19, Six Hills Way, Stevenage, Herts SG1 2DA. Telephone: Stevenage (0438) 312422 Ext. 2972 (out of office hours Stevenage 312878)

BRITISH AEROSPACE
DYNAMICS GROUP
Stevenage Division

BRITISH AEROSPACE

Unequalled in its range of job opportunities.

HAILEYBURY COLLEGE HERTFORD
Physics

A GRADUATE to teach Physics at all levels is required for April or September. Ability and willingness to assist in the supervision of electronics projects and in the interfacing of computers with scientific experiments would be an advantage but is not essential. He or she would also have the opportunity to contribute outside the classroom in the life of a predominantly 13-18 year old boarding school. Salary on the Haileybury scale (above Burnham). Accommodation likely to be available. Further details, and applications, with curriculum vitae and the names of at least two referees, made to: The Master, Haileybury, Hertford SG13 7NU. Tel (0992) 462352.

NORTH WEST WATER AUTHORITY
RIVERS DIVISION

SCIENTIFIC OFFICER (CHEMIST)

(£7290 – £9033)

Based at Carlisle, you will undertake the chemical and physical analysis of surface waters, groundwaters, sewage effluent and trade wastes, and report the results in accordance with daily and weekly work schedules and safety procedures. You should be qualified to degree level in chemistry, although consideration will be given to holders of HNC (or HND) in chemistry, who have considerable analytical experience.

Application forms for the above post and job description from the Personnel Officer, Rivers Division, North West Water Authority, New Town House, Buttermarket Street, Warrington. Tel Warrington 53999 Ext 324.

Closing date for applications 17 February, 1984.

The Authority is an equal opportunity employer.

THE ROYAL FREE HOSPITAL

Medical Electronics Department—

MEDICAL PHYSICS TECHNICIAN III

Salary on scale £7174–£8968 incl An Electronics Technician is required to assist with the development and maintenance of electronic circuits and systems.

Applicants should hold the Ordinary Tec Certificate in appropriate subjects or an equivalent of higher qualification, and have good practical experience in the design of electronic circuits using state-of-the-art techniques. Quote ref 0758.

Department of Psychological Medicine

An electronics engineer with experience of microchip technology and a major interest in microprocessors and computing is required to be in day to day charge of the electronic and computing laboratories in the Department of Psychological Medicine.

The department is well equipped and is actively engaged in collaborative research developing electronic and microcomputer applications in Psychology and Psychiatry.

The post is one of three and the salary scale will depend on the applicants qualifications and experience. Quote ref 1721.

Application form and job description available from the Personnel Dept., Royal Free Hospital, Pond Street, Hampstead NW3.

Tel (01) 794 0500 ext 4286.

Closing date 9 March, 1984

HAMSTEAD HEALTH AUTHORITY

UNIVERSITY OF LEICESTER
Department of Astronomy
POSTDOCTORAL RESEARCH APPOINTMENT

An SERC-supported Postdoctoral Research post is available for work on the determination of the geoid from satellite altimetry data. The project is linked with the UK interest in satellite laser ranging, and is intended to assist UK participation in future satellite altimetry programmes. The person appointed will be based in Leicester, but will collaborate with workers in Oxford and at the Institute of Oceanographic Sciences.

Applicants should have an appropriate background in physics or mathematics and interest in geophysics and geodesy. The post is tenable for three years at a starting salary up to £8080. The appointment is to be taken up, if possible, on 1 April, 1984.

Applicants should send a curriculum vitae, together with any other relevant information, and should arrange for two referees to write in their support. Applications and references should be received by 2 March, 1984 and should be addressed to Professor A. J. Meadows, Astronomy Department, The University, Leicester LE1 7RH, to whom any enquiries should also be directed.

BIOCHEMISTS

£7000 – £10 000 + car

Do you think you could sell?

Several of our Client Companies marketing diagnostic reagents and scientific equipment used in both routine and research laboratories are seeking young outgoing biochemists aged (21-32) with relevant working experience to promote their products into research and hospital laboratories.

Vacancies exist in the following product and geographical areas: –

EMIT/ELISA AND RIA. KITS	LONDON/H. COUNTIES S. WEST/WESSEX TRENT/E. ANGLIA
BLOOD GAS ANALYSERS/ FLAME PHOTOMETERS	S. EAST U.K. MIDLANDS/N. WEST
SCINTILLATION/ISOTOPIC COUNTERS/CONSUMABLES	LONDON/H. COUNTIES N. WEST/YORKS AND SURROUNDING
SPECTROPHOTOMETERS/ HPLC EQUIPMENT	LONDON/H. COUNTIES MIDLANDS/YORKS

These are but a few of the openings we currently have available.

Do not hesitate, ring F. Maranelli or C. Randall now on **01-242 4266 or 01-831 6471.**

Scientific Staff Consultants
50 Lincoln's Inn Fields, London WC2

SSc
SCIENTIFIC STAFF CONSULTANTS

CHEMISTS

SURREY

Serono Diagnostics, which is part of a successful international organisation, is engaged in the development of immunoassays for the clinical diagnostics market. The company will shortly complete its relocation to new premises in Woking, Surrey. Major expansion of the research group necessitates the recruitment of two innovative Research Chemists to work on the development of immunodiagnostic reagents within a highly sophisticated R & D group. Candidates for each vacancy must be PhD's with appropriate experience.

Synthetic Organic Chemist

To undertake the microscale modification and purification of small hormone molecules and their analogues. Applicants should have broad experience of organic synthesis and HPLC, as applied to biologically active molecules.
Ref. R841

Protein Chemist

To work on the chemical manipulation of monoclonal antibodies and enzymes. Previous experience of enzyme labelling techniques is essential.
Ref. R842

Successful applicants would be involved in all stages of reagent development and would provide a source of expertise to other members of the research group. Competitive salaries will be offered, dependent on experience, together with substantial company benefits.

Written applications with full CV should be sent to Diane Woodger:

Serono
DIAGNOSTICS

Serono Diagnostics Ltd
263-269 City Road
London EC1V 1JX

BIOTECHNOLOGY

SENIOR INFORMATION OFFICER

CELLTECH is one of the World's leading specialist biotechnology companies. Based in the UK, the company is backed by major City of London financial institutions. A strong scientific team has now been built up in the areas of recombinant-DNA and cell-hybridisation and continued expansion is envisaged; close links are also maintained with the academic community. The company aims to exploit the potential of discoveries arising in the field of biotechnology, and commercial successes have already been achieved in several areas.

A vacancy has recently arisen in our Information and Library Service for a Senior Information Officer. Duties will include management of an in-house Prime minicomputer-based information retrieval system, scanning current scientific and commercial literature, online searching, etc.

The successful candidate (probably aged 25–30), will join a team of five based within our Business Development function. A degree is essential (preferably in biochemistry or microbiology), possibly some experience of scientific research work and 2–5 years' industrial information work. An MSc or other higher qualifications would be desirable. A competitive salary is offered plus a good range of fringe benefits.

This is a demanding position and we are looking for a unique blend of professional skill, management potential, relevant knowledge and dynamic dedication!

If you think you fit the bill, please send a full C.V. and details of current salary (quoting reference number 196), to Jane Walley, Celltech Limited, 244 Bath Road, Slough, Berks. SL1 4DY.

CELLTECH

ADAS
Agricultural Science Service

AGRICULTURAL SPECIALISTS
Wide-ranging opportunities of vital national importance

The main aim of the Agriculture Service of ADAS is to increase productivity in the farming industry. This is achieved by the provision of technical and economic information and advice on agricultural and horticultural production and by promoting the results of investigational and development work undertaken by the Service. The monitoring of current trends in the industry and the provision of accurate information on the farming scene is an important supplementary function. Vacancies for Advisory Officers exist in various parts of England and Wales in the following disciplines:

AGRICULTURAL ENGINEERING

You will provide advice to farmers and growers on all aspects of mechanisation and encourage the adoption of methods leading to greater productivity. There are opportunities for specialisation and for some research and development work.

AGRICULTURE

As an Agricultural Advisory Officer, located in one of the Ministry's Divisional or Area Offices, you will be in close touch with farmers. You will provide advice, promote new technology and carry out investigational studies leading to improved farm practice. Other responsibilities include writing technical articles for the Press and other publications, organising promotional events and technical administration of certain statutory schemes.

DAIRY HUSBANDRY

The work involves technical supervision of the production and handling of milk on farms under the Milk and Dairy Regulations. In addition, you would advise dairy farmers on many aspects of husbandry and technology of milk production. Promoting new techniques and management systems will be important aspects of your work. Identifying factors which limit productivity and innovations in husbandry practice provides opportunities for involvement in investigational and development projects.

HORTICULTURE

Horticultural Advisory Officers advise producers of horticultural crops, covering fruit, vegetable, glasshouse, hardy ornamental and bulb flower crops. You would take a special interest in the types of horticulture within your area and in related experimental and development work conducted at experimental horticulture stations. There are also opportunities for appointment to these experimental stations.

LIVESTOCK HUSBANDRY

You will specialise to some extent in dairy cattle, beef cattle, sheep or pig production. The work includes advising farmers on livestock husbandry, participating in research and development and encouraging the adoption of new and improved technology. In addition the Livestock Group has a responsibility of advising on the effective selection, testing, evaluation and use of AI sires.

POULTRY HUSBANDRY

You will advise the poultry industry on good husbandry and efficient production. This involves advisory visits to farms, preparing technical leaflets and local press articles, and group discussion meetings. Officers in this field also take an active part in development work.

SALARY AND QUALIFICATIONS

You may be appointed to one of two grades depending on your qualifications and experience: for appointment to Grade IV (£5680-£7765) you must have, or obtain in 1984, a degree or equivalent in a relevant subject. For appointment to Grade III (£7325-£11,475) you should normally have a relevant degree with at least 3 years' appropriate postgraduate experience.

A full valid UK driving licence is essential.

FINAL YEAR STUDENTS MAY APPLY.

For further details and an application form (to be returned by 2 March 1984) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Please quote ref: S(A)906.

Ministry of Agriculture, Fisheries and Food

AQUATIC AND TERRESTRIAL INVERTEBRATE ZOOLOGISTS

To join 5th Oxford Canal Project. Aquatic post £60 per week possibly increasing in May, computing knowledge desirable. Terrestrial Post £40 per week. Candidates should meet MSc elegibility. Scheme finishes 22 August, 1984.

Tel Joanne Heppenstall, 0295 52535 Ext. 171 for form, to be returned by 24 February, 1984.

UNIVERSITY OF LANCASTER
Department of Environmental Sciences
RESEARCH ASSOCIATE

Applications are invited for the post of postdoctoral Research Associate to work with Dr R. M. Harrison, Dr M. Kelly and Dr S. R. Aston on a two year study of transuranic radionuclides in the estuarine environment. Applicants should possess a PhD, degree, and research experience in environmental chemistry or geochemistry would be advantageous. Salary is in the range £7190–£8530 pa.

Further particulars may be obtained (quoting reference LO11/B) from the Establishment Office, University House, Bailrigg, Lancaster LA1 4YW, where applications (seven copies) naming three referees, should be sent not later than 24 February, 1984.

UNIVERSITY OF WARWICK

The Department of Computer Science invites applications for the following posts:

LECTURESHIP IN SOFTWARE ENGINEERING/MMI

A permanent post is available for teaching and research in the Department. Preference will be given to candidates with research interests in Software Engineering or in Machine Interface design. The appointee will be expected to involve himself/herself particularly with teaching for Warwick's Computer Systems Engineering degree course. Initial salary at an appropriate point on the Lectureship scale: £7190-£14 125 pa. Further particulars and application forms from the Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref No: 27/A/84/F. Closing date for receipt of applications 1 March, 1984.

LECTURESHIP IN ROBOTICS

A permanent post is available for research in the department's Robotics Laboratory, and for teaching in the department's undergraduate programme. Research responsibilities would initially be associated with software for the control of multiple-sensor, mobile, manipulative robots. The research is expected to involve the use of programming languages for concurrent programming, eg OCCAM. The post is supported by the British Government's Information Technology Initiative. Initial salary at an appropriate point on the Lectureship scale: £7190-£14 125 pa. Further particulars and application forms from the Registrar, University of Warwick, Coventry CV4 7AL quoting Ref No: 27/2A/84/F. Closing date for receipt of applications 1 March, 1984.

RESEARCH ASSOCIATE: KNOWLEDGE BASED SYSTEMS

Applications are invited for a Research Associate post on an SERC project to investigate the design and use of many-sorted logic as a knowledge representation language and as the basis for a typed logic programming language. The post is funded initially for two years. Candidates should have a research background in computational logic and/or experience in implementing knowledge based systems. Candidates with other backgrounds may also be considered. Salary on the Research Range 1A scale: £7190-£11 615 pa. For this post applicants should send a detailed curriculum vitae together with the names of two referees, as soon as possible to Dr A. G. Cohn, Department of Computer Science, University of Warwick, Coventry CV4 7AL. Further information may be obtained by telephoning 0203 24011, Ext 2088.

KING'S COLLEGE SCHOOL OF MEDICINE AND DENTISTRY

of King's College London
Denmark Hill
LONDON SE5 8RX

RESEARCH ASSISTANT (MLSO)

Applications are invited for the post of Research Assistant to work on the development of coagulation inhibitors in the Thrombosis Research Unit. Candidates should be graduates in biochemistry or pharmacology, and preferably with some experience in protein purification and/or enzymology.

Salary £6533-£7168 pa.

Applications, naming two referees and quoting Ref: CT/R2, should be sent to the Secretary of the School at the above address by 23 February, 1984.

Applied Physicist

We are world leaders in the design, development and manufacture of electro-optical systems for both military and civilian use. Continued expansion of our research and development programme has created the requirement for Physicists to join our Applied Physics Group. Technological innovation in this area has created work on sophisticated M.o.D. contracts which involve:

(a) The investigation of infra-red optical thin film design and practical development, with particular reference to RF Sputtering and Plasma Assisted Chemical Vapour Deposition.

(b) The study of optical materials, thin films and surfaces, particularly their interaction with laser radiation, and the development of associated sophisticated measurement facilities.

Candidates should hold an Honours degree in Physics or a closely related discipline and have the necessary practical attributes to accept project responsibility. Experience in related work is desirable.

We offer an attractive salary, related to experience and qualifications, company bonus scheme and a pension and life assurance scheme. Relocation assistance is available where appropriate.

Please telephone or write for an application form to:

Donna Green
Personnel Officer
Barr & Stroud Limited
Caxton Street Anniesland
Glasgow G13 1HZ
041 954 9601 ext. 150

Barr & Stroud
Technologists of excellence

Head of Department of Pharmacology

We are Europe's largest Research Organisation located in rural East Anglia. We carry out vital work, evaluating the efficacy and biological safety of pharmaceutical products, pesticides and industrial chemicals.

Applications are invited for this senior appointment at Huntingdon Research Centre plc. The department of approximately 20 staff is involved in a wide range of studies, covering many aspects of pharmacological testing for clients world-wide.

The successful applicant will probably have a higher degree and some 7 - 10 years of experience in an industrial environment, in addition to an in-depth expertise in their own areas of research. A broad knowledge of other areas of pharmacology will be expected. Good organisational ability is also essential for this very demanding, but rewarding appointment.

The job will involve some overseas travel, mainly in Europe, but also in the U.S.A. and Japan.

In return, we offer a competitive salary and a full range of benefits, which include a company car, free medical insurance, permanent disability insurance, pension and assistance with re-location.

Please write giving full details and experience, qualifications and expected salary to: J. West,

HRC

Director of Human Resources
and Administration,
Huntingdon Research Centre plc,
Huntingdon PE18 6ES.

Huntingdon Research Centre

University of Strathclyde

DEPARTMENT OF BIOSCIENCE AND BIOTECHNOLOGY

Applied Microbiology Division

RESEARCH TECHNICIAN (Grade 5)

£6279-£7332

Applications are invited for the position of Research Technician to work with Dr D. R. Berry and Dr J. R. Johnston on a project concerned with the genetic manipulation of yeast strains.

The appointment is for a period of three years and the successful candidate will be experienced in microbiological and fermentation techniques.

Applicants should hold a Higher "TEC" Certificate or equivalent in an appropriate subject and have at least eight years' relevant experience.

Only those applicants called for interview will have their applications acknowledged.

All applications must be in writing, quoting reference BST6, with details of age, experience and qualifications, etc, to: **The Personnel Officer, University of Strathclyde, McCance Building, 16 Richmond Street, Glasgow G1.**

The Central Blood Laboratories Authority, which is pleasantly located in rural Elstree, Herts has a vacancy for an

Animal Technician

in the Pyrogen Testing Unit

The Testing Unit carries out in vivo control testing of plasma products and maintains many of the common laboratory animal species.

Applications are invited for a post as Technician to be responsible to the Section Head for the performance of pyrogen and acute toxicity tests, in addition to routine husbandry duties.

The successful candidate will be an Associate of the IAT or hold equivalent TEC Certificate and will hold a Home Office Licence. Experience should include Pyrogen Testing during a minimum of four years employment in the field of laboratory animal technology.

The post holder will be required to participate in the weekend duty rosta.

Salary will be in the range £5491-£6436 dependant upon age and qualification.

Further information and application forms are available from Mr B. D. Taylor, Blood Products Laboratory, Dagger Lane, Elstree, Herts. Tel 01-953 6191 Ext 290.

Closing date for applications 24 February, 1984.

COMMONWEALTH AGRICULTURAL BUREAUX

SCIENTIFIC INFORMATION OFFICER

at the

Commonwealth Institute of Parasitology

Duties: Preparing abstracts in English for *Helminthological Abstracts* and *Protozoological Abstracts* which cover world scientific literature in these fields, indexing, and answering scientific inquiries.

Qualifications: A degree in zoological science or related subject, plus a reading knowledge of at least one European language (German preferred) and the ability to write good English. Applicants must be able to render the content of scientific publications into concise, accurate and readable abstracts. It is expected that the successful candidate will wish to make a career in the field of scientific information rather than research.

Salary: In the scales £5682-£7765 pa, £7149-£9561 pa. Starting salary according to qualifications and experience.

Application forms and further particulars from:

Commonwealth Institute
of Parasitology,
395A Hatfield Road,
St Albans,
Herts AL4 0XU
Tel 0727 33151

Closing date for applications 1 March, 1984.

HONOURS GRADUATES

SEEING ISN'T ALWAYS BELIEVING

● ●

At the moment there are 2 dots in front of you. Cover your right eye and look directly at the right hand dot with your left eye. Slowly move your head up and down and at some point, the left hand dot will vanish. This is called the blind spot.

Appearances can deceive — things are not always as they seem on the surface. As a Tax Inspector, you have to get at the underlying facts in a case, using your powers of analysis, perception and intuition in order to reach a fair conclusion. In doing this, you are involved in many face to face interviews with business people and their advisers in all walks of life — from the one man band, to the £multi-million, multi-national.

Within a few months, you can expect to be handling your own casework. After 3 years you will be managing a sizeable team of staff — and in due course you should be running your own tax district.

Qualifications: Under 32 and a degree with at least second class honours or an acceptable equivalent qualification. Final Year Students may apply.

Starting salary £5785-£7980 according to experience. You should be earning £8780 after 2 years and £12395 3 years later. Within 11 years you could be on a salary scale rising to £20790. In another 5 years you could be on a scale rising to £23155. Beyond this there are opportunities for further promotion to the most senior grades in the Civil Service. SALARIES HIGHER IN LONDON. Training can usually begin at an office in the area of your choice.

To find out more and for an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote ref: A/320/171.**

UNIVERSITY OF LIVERPOOL

Department of Geography

Applications are invited for

POSTDOCTORAL
SENIOR RESEARCH
ASSISTANTSHIP

in the Department of Geography to work on an investigation of global cloud data archiving and analysis.

Applicants should hold a PhD in atmospheric science or physics and have considerable experience in computing. He or she must be able to undertake independent research, be prepared to attend international meetings and to collaborate with research scientists at the US Air Force Research Geophysics Laboratory in Massachusetts. Considerable experience has been established by this group. It is hoped the successful candidate will be able to draw upon developed techniques as well as contributing new ideas to the understanding of cloud observations from surface bases and satellites.

The project is financed on a year-by-year basis for two years from 1 March, 1984. The initial salary on the scale £7190-£8530 pa.

Applications, together with the names of three referees, should be received not later than 28 February, 1984, by The Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote Ref RV/222/NS.

NORTH EAST THAMES REGION
IMMUNOASSAY UNIT

BIOCHEMIST

Salary Scale £6723 – £9391 pa incl:

This new post has been created in this unit, associated with the Department of Chemistry Pathology at St Bartholomew's Hospital.

Experience of RADIOIMMUNOASSAY and CLINICAL CHEMISTRY would be useful and for a suitable candidate there could be an opportunity to work for a higher degree.

For further details about this post please contact Dr Edwards on 01-606 2113.

Application forms available from the Personnel Department, St Bartholomew's Hospital, London EC1A 7BE, or telephone 01-600 9000 Ext 3188 quoting reference TGL115.

LOTHIAN HEALTH BOARD AND UNIVERSITY OF EDINBURGH
Department of Medical Physics and Medical Engineering

SENIOR PHYSICIST

Applications are invited for a post in the Radionuclide Section of the Department. Duties at the Royal Infirmary of Edinburgh and elsewhere in the Area will include various aspects of radionuclide and other (eg CT) imaging and data processing. There is an active research programme, particularly in body composition studies.

Applicants should have a good honours degree in Physics and a minimum of four years experience in the basic grade or equivalent.

Salary scale £9010-£11 649 per annum. Further particulars on request.

Applications, typewritten and giving particulars of age, qualifications and previous experience together with the names and addresses of two referees should reach the Personnel Officer, 11 Drumsheugh Gardens, Edinburgh EH3 7QQ by 24 February, 1984. Please quote M/22.

THE UNIVERSITY OF LEEDS
ASTBURY DEPARTMENT OF BIOPHYSICS

POSTDOCTORAL RESEARCH FELLOW

IN THE DESIGN OF
ENZYME INHIBITORS
USING
COMPUTER GRAPHICS
in collaboration with
G. D. SEARLE & CO

Applications are invited for the above post for research on computer model-building and molecular mechanics studies leading to the development of enzyme inhibitors for clinical use as drugs. The project will make use of an Evans & Sutherland PS300 colour display system. Applicants should have, or be about to obtain, a PhD degree in protein crystallography, molecular graphics or related structural studies. The appointment is funded by an SERC Co-operative Research Grant and is for a fixed period of up to two years.

Salary on the 1A Range for Research and Analogous Staff (£7190-£11 615), according to age, qualifications and experience.

Informal enquiries may be made to Dr A. J. Geddes or Professor A. C. T. North of the University of Leeds, Tel (0532) 431751 Ext 7088 or 6130.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference no 42/5/E. Completed applications should be returned to the Registrar as soon as possible.

UNIVERSITY OF ABERDEEN

Department of Bio-Medical Physics and Bio-Engineering

CLINICAL PHYSICIST

Applications are invited from Physicists for a temporary post in the Radiation Protection Section of the Department. The post, based in the Aberdeen Royal Infirmary, is for one year with the possibility of an extension for a further year. The work will be concerned with establishing quality control procedures in the Radiology Departments and helping with the implementation of new legislation. The successful applicant will be primarily concerned with the instrumentation involved in quality control and will have to become familiar with the work involving ionizing radiations carried out in the hospital.

Salary within Grade IB Scale for Other Related Staff, £6310-£9875 pa, depending on qualifications and experience.

Further particulars and application forms from The Secretary, The University, Aberdeen, with whom applications (two copies) should be lodged by 1 March, 1984.

UNIVERSITY OF CAMBRIDGE

Computer Laboratory

COMPUTER MANAGER

Site manager for Alvey IKBS Infrastructure Series 63 Machine. Responsible for hardware and software management, usage administration, support programming for Artificial Intelligence research. Standard university pay and conditions to a maximum of £12 545 pa. Further information may be obtained from the Head of Department, Computer Laboratory, Corn Exchange Street, Cambridge CB2 3QG to whom applications including a curriculum vitae and the names of two referees should be addressed so as to reach him not later than 20 February, 1984.

Royal Postgraduate Medical School

(University of London)

Department of Medical Physics and Computing Science

The Department, based at the Hammersmith Hospital Medical School, has the following vacancies for which applications are invited

Computer

Computer Scientist (Section Head)

A highly qualified and well motivated Computer Scientist is required to head the Computer Centre which is part of the Department of Medical Physics.

The successful applicant will have a background in computer science coupled with a good working knowledge of software and computer hardware.

This post provides a unique opportunity for the right person to make a significant contribution to medical research and new hospital clinical and laboratory developments.

Post Reference 8/005.

Research Programmer

Applicants will be expected to have a background in Computer Science or some other relevant scientific discipline. Experience in Statistics would be and advantage.

Post Reference 8/110.

Basic Grade Physicist

A Basic Grade Physicist is required to take an active part in research projects that originate in the Royal Postgraduate Medical School/Hammersmith Hospital. Duties will include planning of projects, and maintenance and support of systems software on the local machines.

The successful applicant will have a background in computer science or other scientific discipline.

Post Reference 8/207.

Nuclear Magnetic Resonance (NMR)

A Senior Physicist/ Electronic Engineer

is required for three years in the first instance to join a group working on the assessment and development of NMR imaging techniques.
An ideal candidate would have experience of either digital electronics or radiofrequency systems.

Post Reference 8/NMR.

Salary Scales

Post 8/005 - Academic Related Grade II £11 160 to £14 125 plus £1 186 London Allowance a year.

Post 8/110 - Academic Related Grade 1B £6310 to £9875 plus £1186 London Allowance a year.

Post 8/207 - Basic Grade Physicist (NHS) £5681 to £8340 plus £1042 London Allowance a year.

Post 8/NMR - Senior Physicist (NHS) £9010 to £11 648 plus £1042 London Allowance a year.

Application forms and further particulars can be obtained from the Personnel Office, Royal Postgraduate Medical School, Hammersmith Hospital, 150 Ducane Road, London W12 0HS, quoting appropriate post reference numbers.

Closing date for all posts is 28 February, 1984.

MRC RADIOBIOLOGY UNIT, HARWELL

IMMUNOLOGIST

Applications are invited for a SHORT TERM NON-CLINICAL SCIENTIFIC post in this Medical Research Council Unit, tenable for three years, to work with a group of scientists studying the effects of radiation, and the application of monoclonal antibodies in tumour systems. Candidates of immediately post-doctoral or equivalent ststus will be preferred. It is expected that the successful applicant will have some experience in the field of monoclonal antibody production.

Salary and conditions of service according to MRC non-clinical scientific scales. Hostel accommodation or housing may be available.

Please write or telephone if you would like further information about this post. Applications, together with curriculum vitae and the names of two referees, should be sent to the Personnel Officer, MRC Radiobiology Unit, Harwell, Didcot, Oxon OX11 0RD, Tel 0235 834393.

Closing date 27 February, 1984

THE NATIONAL INSTITUTE FOR MEDICAL RESEARCH

RESEARCH OFFICER/ TECHNICIAN

Research Officer/Technician required for basic research on structure and function of cell virus components. Physics rather than a biology background an advantage. The applicant should hold a degree or equivalent qualification. Experience preferred in high resolution biological transmission electron microscopy and associated skills.
Salary depending on age and experience will be in the range £6087 pa to £8722 pa inclusive. Please telephone for an application form on 01-959-3666 extension 221 or write to Mrs. P. A. Wilde, Personnel Officer, NIMR, The Ridgeway, Mill Hill, London NW7 1AA. Please quote reference RO/V.

UNIVERSITY OF STRATHCLYDE

Department of Applied Physics

TEMPORARY LECTURESHIP

Applications are invited for a Temporary Lectureship (tenable until 30 September, 1986) from applied physicists, biophysicists and engineers. Applicants with industrial experience, eg on secondment, will be specially welcome.

The successful candidate will be expected to undertake varied teaching duties, and to join in one of the multi-disciplinary research activities of the Department: Photophysical Instrumentation, Environmental Physics, Renewable-Energy Technology, Superconducting Devices, and Population Ecology. Candidates should have experience in one of these areas.

Further details and application forms (quote 6/84) are available from Academic Staff Office, University of Strathclyde, McCance Building, 16 Richmond Street, Glasgow G1 1XQ. Closing date for application 28 February, 1984.

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BSc-PhD **Salaries to £16 000**

Our clients are engaged in advanced Defence and Aerospace Projects and require **Systems Engineers** with experience in MODELLING, SIMULATION, FEASIBILITY STUDIES, TRIALS ANALYSIS, SIGNAL PROCESSING, OR, HARDWARE/SOFTWARE DESIGN.

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For a Free Information Pack and an application form contact John Spencer at the address below or send a detailed CV. Full confidentiality assured.

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LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

LECTURER IN PHYSICS

Applications are invited for the post of LECTURER in the Department of Physics. The person appointed will be expected to contribute to the teaching of the Department's honours courses in Physics and in Electronic Engineering and Physics, and to join one of the existing research groups within four main areas of interest; applied optics, material mechanics, solid state physics and surface physics.

The appointment will be for three years in the first instance and will be made on the lower half of the lecturer scale £7190-£14 125. Application forms and further particulars from Paul Johnson, Establishment Officer, ref. 84/6 PH.

Loughborough *Leicestershire*

PHARMACEUTICAL ANALYST

A small but expanding pharmaceutical company seek an experienced pharmaceutical analyst. The work will involve the day to day quality control of incoming tablets, capsules, liquids, etc, and also the development of analytical methods and subsequent testing for stability trials on new products. Knowledge and experience of high pressure liquid chromatography as applied to pharmaceuticals is essential. Previous work on analysis of drugs in plasma would be an advantage.

Please write giving full qualifications and career details to date, together with an indication of salary requirements.

To Box D 786.

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DRUG DESIGN AND DEVELOPMENT

METABOLISM AND KINETICS

Pfizer Central Research is part of a multi-national organisation engaged in the research, development, manufacture and marketing of a wide range of human and animal health products.

Currently over 500 scientists and supporting staff work at Sandwich in modem, well equipped laboratories. An additional 70,000 sq ft of laboratory and office space is currently being built and will be ready for occupation in the summer.

At that time we shall need an additional high calibre PhD to join our Drug Metabolism Department. We are seeking a chemist/biochemist or analytical chemist who is completing his/her PhD research project in metabolic biochemistry, pharmacokinetics or bioanalysis this year, or someone with up to 3 years' post-doctoral experience in these areas.

The function of drug metabolism is to provide information on the absorption, distribution, metabolism and excretion of drugs in laboratory animals and man. Firstly, so that a better understanding of the mode of action and toxicology can be achieved and, secondly, to aid in the design of drugs with a more desirable pharmocokinetic profile. The department has a major commitment to the application of drug metabolism to the drug discovery process and the person we seek will be self-motivated and enjoy the challenge of being responsible for the development of assay methods and suitable animal models for the study of the kinetics of potential new drugs.

Pfizer

This exciting new appointment offers a highly competitive basic salary plus a bonus related to personal performance. We have a thriving sports and social club with first-class facilities. We also offer generous help with relocation expenses.

If you are interested in this appointment, please send your cv, in confidence, to:— D. W. Sells, Personnel Manager, Pfizer Central Research, Ramsgate Road, Sandwich, Kent CT13 9NJ.

SCOTTISH AND NEWCASTLE BEER PRODUCTION LIMITED

Assistant Microbiologist

Applications are invited from Microbiology graduates, or equivalent, who have already gained some experience in food or drink manufacture.

Based within the Tyne Brewery Laboratory, the job holder will assist in the conduct of routine and investigational quality control of our production processes and products.

This position offers an ideal opportunity to develop a knowledge of brewing technology and the management skills essential to future career progression.

The Company offers a competitive salary, a range of attractive employee benefits and good career prospects. Assistance with relocation will be provided if required.

Application forms may be obtained by telephoning **Newcastle 325091 ext. 4328** or by writing to:

Mr. R. Fokerd, Personnel Manager, Scottish & Newcastle Beer Production Limited, Tyne Brewery, Gallowgate, Newcastle upon Tyne, NE99 1RA.

Scottish & Newcastle Breweries plc

CLYDE SURVEYS LTD

require an

EARTH SCIENTIST

Clyde Surveys Ltd wish to recruit an Earth Scientist with considerable experience in remote sensing to head its Environment and Resources Consultancy in Maidenhead.

The successful applicant will be expected to initiate and implement a programme of expansion and will therefore posses ability in leadership, marketing and commercial acumen. Substantial knowledge of remote sensing technology and experience of applications, particulary in the fields of satellite and thermal infrared linescan imagery will be required.

Applicants should possess a minimum of 10 years experience since their first degree with the major part being in a commercial environment. A higher degree in an appropriate subject would be advantageous.

Salary and relocation costs are negotiable and a car will be provided.

Interested applicants should write direct to the Managing Director at the address below, enclosing a copy of their CV and details of their present and expected salary. It is intended that interviews of those short-listed will be held during the second half of February.

Clyde Surveys Ltd, Clyde House,
Reform Road, Maidenhead, Berkshire SL6 8BU.

INSTITUTE OF CANCER RESEARCH

Fulham Road, London SW3

A POSTDOCTORAL

vacancy exists in the Chemical Carcinogenesis Section for a scientist with experience of recombinant DNA research to join a team working on the molecular basis of mutation and transformation of mammalian cells by carcinogens. The scientist appointed will have as close colleagues members of both the Chemical Carcinogenesis and Cell and Molecular Biology Sections of the Institute, and will be encouraged to develop his or her own ideas in relation to the overall problem. The appointment will be for a minimum of three years, with salary appropriate to age and experience within the scale £7630-£10 250 pa, plus London Allowance of £1186 pa and superannuation (USS).

Applications with full career details in duplicate and the names of two referees should be sent to the Personnel Officer, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting ref. 300/G/41. Further details of the post may be obtained by contacting Professor P. Brookes (Tel 02404-2326).

MEDICAL RESEARCH COUNCIL

Developmental Neurobiology Unit

There is an immediate vacancy for the post of a

TECHNICIAN

to assist in a research programme in cellular and developmental neurobiology. Applicants should have laboratory experience in biochemistry and some knowledge of tissue culture techniques and cell biology, a degree would be an advantage.

Starting salary, depending on experience, will be in the range of £5491-£7747 plus £932 London Weighting. Please apply with CV and the names of two professional referees to Robert Balazs, MRC DNU, 33 John's Mews, London WC1N 2NS. Tel: 01-242 1496.

Top Industrial Scientist

Food and Beverages to £30,000+benefits

Head of Research and Technical Development is to be appointed by international leader in consumerable products. Externally, to represent group technical interest at trade, Government and international levels. Internally, to direct and co-ordinate the work of several research laboratories and technical functions. Objectives are continued industrial leadership in technology and cost effective services within the group.

Wide experience of directing commercially accountable research and the supervision of analytical and technical services is essential. An appropriate science or chemical engineering degree is required.

The applicant must have experience with work involving public and trade committees. Ability to identify, negotiate and manage change is important as is the administration and control of a scientific service.

Write in confidence to Hamilton Howatt, John Courtis and Partners, Selection Consultants, 310 Chester Road, Hartford, Northwich CW8 2AB, showing clearly how you meet our client's requirements, quoting reference 363/NS. Both men and women may apply.

John Courtis ...and Partners...

DEPARTMENT OF MICROBIOLOGY
ST. RICHARD'S HOSPITAL

Junior Medical Laboratory Scientific Officer

(GRADE B)

Applications are invited for the above post in this laboratory which covers a wide range of microbiological investigations.

Qualifications: BSc in the biological sciences related to mammalian studies. Under current regulations a candidate will be eligible to apply for State registration after one year's training. Promotion to Medical Laboratory Scientific Officer (Basic Grade) is automatic following state registration.

The department offers good opportunities for further study and the successful candidate will be encouraged to study for the Special examination of the Institute of Medical Laboratory Sciences. This qualification is required for further promotion.

Chichester is a cathedral city on the south coast and offers excellent recreational facilities.

Informal visits arranged and further information on request to Mr C. Dowding. Tel Chichester (0243) 788122, Ext 720.

Application forms from Unit Personnel Department, St. Richard's Hospital, Spitalfield Lane, Chichester, West Sussex PO19 4SE. Tel Chichester (0243) 788122, Ext 445. Closing date: 29 February, 1984.

Chichester
HEALTH AUTHORITY

KING FAISAL UNIVERSITY
AL-HASA, SAUDI ARABIA

College of Agriculture and Food Sciences invites applications for faculty positions in the following disciplines:

MEN'S COLLEGE
—Agricultural Climatology/Water Resources
—Farm Power and Machinery
—Agricultural Engineering
—Rural Sociology
—Horticulture, Crop Physiology and Genetics
—Poultry and Animal Breeding
—Meat Science and Technology
—Fish Sciences
—Analytical Chemistry (preferably Computer-Aided Chemistry)

WOMEN'S SECTION
—Child Development and Family Life
—Home Management and Family Finance
—General and Organic Chemistry

APPLICANTS MUST BE FLUENT IN BOTH ARABIC AND ENGLISH

Requirements: PhD for Assistant and Associate Professors. Master's degree for Lecturers. Publications and minimum of two years' teaching experience for Assistant Professors and four years for Associate Professors.

Salaries are highly competitive. Contracts are for one year renewable.

Benefits include free furnished housing or housing allowance, annual return air tickets for a family of four, 60 days paid annual leave, generous luggage overweight allowance, educational allowance for children. No Saudi tax.

Application forms can be obtained from either of the following addresses, stating clearly the position applied for:

Dean, College of Agriculture and Food Sciences
or

c/o UK Recruiting Office
King Faisal University
29 Belgrave Square
London SW1X 8QB

King Faisal University
PO Box 420
Al-Hasa
Saudi Arabia 31982

Closing date for applications 9 March, 1984

Pharmacologist

Merck Sharp & Dohme Research Laboratories is a leading International pharmaceutical research organisation which is establishing a Neuroscience Research Centre on a 30 acre greenfield site near Harlow, Essex The Centre will be one of the world's largest laboratories dedicated to neuroscience research initially focussing on: the study of inhibitory chemical messengers in the brain and exploration of the functional role of neuropeptides in the control of emotion, appetite, memory and learning.

An opportunity exists in the behavioural pharmacology department for a graduate assistant. Applications are invited from pharmacology graduates who have at least 12 months postgraduate experience in the study of the central nervous system or related fields. ideally this will have been gained in the pharmaceutical industry

Salary and fringe benefits are highly competitive although of equal importance will be the opportunity to work in a stimulating and innovative research environment.

Applications, enclosing a full C.V. and stating current salary, should be sent in the first instance to Andrew Harley, Personnel Manager, Merck Sharp and Dohme Research Laboratories, Hertford Road, Hoddesdon, Herts EN11 9BU.

MERCK
SHARP
DOHME
MSD

Neuroscience Research Centre

THE BRITISH COUNCIL

SCIENTISTS, ENGINEERS AND TECHNOLOGISTS

Careers in the British Council's Overseas Service

The British Council, a publicly funded body whose aim is to promote an enduring understanding and appreciation of Britain overseas through cultural, educational and technical cooperation, intends to recruit staff with qualifications in science, engineering or technology for its Overseas Career Service. At present the Council has staff in over 80 countries throughout the world and those appointed to the OCS undertake to serve wherever they are posted during their careers. They can expect to spend about two-thirds of their working lives overseas initially in posts that directly use their scientific qualifications and experience, but gradually moving into more general areas of cultural relations work.

Council science work is varied, including contact and liaison with British institutions and their counterparts overseas; advisory and administrative work on the Council's various scholarship and visitor programmes, the promotion of research links and collaboration and professional involvement in science-based project work. A successful career in the OCS entails the performance of a wide variety of tasks in the area of cultural relations. Candidates must possess the qualities that representation of Britain overseas demands and must demonstrate the potential to occupy responsible managerial posts.

Applicants must have a first degree or equivalent in science, engineering, agriculture, technology or a related field, together with relevant professional experience in research, teaching or industry. A higher degree or other postgraduate qualification in science, management or development studies is desirable. Overseas work experience would be valuable as would a knowledge of foreign languages.

Successful candidates are likely to be aged between 26 and 33 but candidates with exceptional qualities outside this range will be considered.

The salary scale on entry is £9,416-£11,463 and promotion prospects offer the possibility of senior positions (salary up to £25,000). During periods of overseas postings allowances and benefits comparable with those of the Diplomatic Service will be paid. There is a non-contributory pension scheme analogous to that of the public sector.

Application forms and an information booklet may be obtained from Staff Recruitment Department, The British Council, 65 Davies Street, London W1Y 2AA or telephone 01-499 8011 ext 3191 or 3462.

The closing date for applications is Wednesday 29 February.

THE ANIMAL HEALTH TRUST
THE BACTERIOLOGY UNIT requires a

LABORATORY TECHNICIAN AND RESEARCH ASSISTANT

THE RESEARCH ASSISTANT is for a 3 year appointment to study the role of obligate anaerobes in the horse. A degree or equivalent is required with laboratory experience in diagnostic bacteriology.
Salary: **£6310—£7190** per annum
The TECHNICIAN should have H TEC (HNC) or equivalent and laboratory experience in bacteriology for mixed practice diagnostic work.
Salary: **£5174—£6037** per annum

Applications in writing with c.v. to:
The Secretary, The Animal Health Trust, P.O. Box 5, Balaton Lodge, Snailwell Road,
NEWMARKET, Suffolk, CB8 7DW.
Telephone
NEWMARKET (0638) 661111

Anglian Water

SENIOR SCIENTIFIC OFFICER £11 184 to £12 408

Based in Colchester, the duties include the provision of a montoring and advisory service to ensure the Authority's water supply quality standards are achieved. Although priority will be given to water supply science, there will be involvement in a wide variety of multi-functional scientific work.

Applicants should be suitably qualified graduates. Preference will be given to candidates with a water treatment/supply background and computing experience would be an advantage.

A casual user car allowance is payable, as are relocation expenses in appropriate cases.

An application form and job description are available from the Personnel Department, Tel Colchester 69171, Ext 205, quoting reference WR1, to be returned by 24 February, 1984.

COLCHESTER DIVISION
Cowdray Centre, Cowdray Avenue,
Colchester CO1 1BY

UNIVERSITY OF SALFORD
DEPARTMENT OF AERONAUTICAL AND MECHANICAL ENGINEERING

RESEARCH ASSISTANT

Applications are invited for the above MoD funded post concerned with the development of an existing computer method for the prediction of external three-dimensional transonic flows. Candidates should have a good honours degree in engineering or mathematics. Experience in Computational Fluid Dynamics, particularly in the areas of grid generation and finite-difference or finite element methods, would be especially useful.

Starting salary up to £8060 pa: USS benefits. The post in tenable for one year in the first instance. Those suitably qualified may register for a higher degree.

Application forms obtainable from the registrar, University of Salford, Salford M5 4WT (Tel: 061-735 5843 Ext 215). To whom completed forms should be returned by 9th March 1984, quoting reference ME/386/NS (Informal enquiries may be made to Dr D. M. Causon Ext 7474).

THE UNIVERSITY OF SUSSEX
School of Chemistry and Molecular Sciences
RESEARCH TECHNICIAN GRADE 4

Applications are invited for the post of Research Technician, Grade 4, for a two-year period to carry out microbiological and chemical work under the supervision of Dr J. R. Hanson. The project involves cultivating fungi, isolating free metabolites and carrying out chemical transformations. Safety protective wear is provided.

Initial salary in the range £5826-£6702 pa. Twenty days paid leave annually, in addition to Bank Holidays and University closures.

Applications, giving a brief curriculum vitae and the names of three referees and quoting reference 4R84, should be sent as soon as possible to Mr P. J. Gilliver, Superintendent of Laboratories, School of Chemistry and Molecular Sciences, University of Sussex, Brighton BN1 9QJ.

MRC RADIOBIOLOGY UNIT, HARWELL

TUMOUR BIOLOGIST/ IMMUNOLOGIST

Applications are invited for a SHORT TERM NON-CLINICAL SCIENTIFIC post in this Medical Research Council Unit, tenable for three years, to work with a group of scientists studying the effects of radiation and drugs on tumour systems. Candidates of immediately post-doctoral or equivalent status will be preferred. It is expected that the successful applicant will have some research experience in at least one of the fields of vascular physiology, experimental tumour therapy or monoclonal antibody production.

Salary and conditions of service according to MRC non-clinical scientific scales. Hotel accommodation or housing may be available.

Please write or telephone if you would like further information about this post. Applications, together with curriculum vitae and the names of two referees, should be sent to the Personnel Officer, MRS Radiobiology Unit, Harwell, Dicot, Oxon OX11 0RD. Tel 0235 834393.

Closing date 27 February, 1984.

ENGINEERS—Mechanical, Electrical, Electronic seeking a position of any level anywhere please submit your curriculum vitae and we will seek out opportunities. No charge to you. WSA (Engineers), 2 Greens End, London SE18 6HX (Agency).

Development Chemist

Technical Services Q.A.

Syntex is a high-growth company and to assist in the further development of our products and manufacturing capability an interesting position has been created.

Working as a member of our technical services group you would be conducting validation programmes to ensure the safety, efficacy and stability of Syntex products. This important function will also entail analytical and formulation development.

Aged at least 25 you should be an Honours graduate scientist with good experience in formulation development within the Pharmaceutical or Cosmetic industry.

We offer a first class range of benefits.

For full information package telephone or write to:
Steve Tindall, Personnel Officer, Syntex Pharmaceuticals Ltd, Ridgeway, Iver, Buckinghamshire
SL0 9JW. Telephone: Iver (0753) 654757.

SYNTEX

TECHNICAL TRANSLATOR SWITZERLAND

The Pharmaceuticals Division of a large Swiss enterprise requires the services of an English translator to join a team at its headquarters in Switzerland.

The work chiefly involves the translation from German into English of technical instructions for use in the production of pharmaceuticals and in the analysis of pharmaceutical chemicals and preparations.

Applications are invited from candidates (aged under 45) of English mother tongue with a degree-level knowledge of German and a degree in chemistry. Well-qualified translators without a scientific degree can also be considered, but they should have had considerable experience in the professional translation of chemical texts. Acquaintance with chemical or pharmaceutical production and analytical methods would be an advantage.

Applications, accompanied by a curriculum vitae, should be addressed to Translators' Guild Ltd, 24a Highbury Grove, London N5 2EA.

Anglian Water

HIGHER TECHNICIAN—RIVERS DEPARTMENT

Salary Grade 5: £8154-£9033

Applications are invited for the above post in the Operations Manager's Department at Boston. The duties include designing and proving programs in Fortran and implementing software packages for 1) A Texas 600 mini-computer which is used in conjunction with a Hydrometric Telemetry System, and 2) The Honeywell level 66 main frame.

Applicants should have a degree or equivalent and relevant experience. Knowledge of hydrometric work would be an advantage.

The post holder is required to work as one of a team in the Hydrological Section and is responsible to the Principal Engineer, Hydrology.

Terms and conditions of service in accordance with The National Joint Staff Council for the water industry.

Application forms, which should be returned by 24 February, 1984, are obtainable from the Office Manager.

LINCOLN DIVISION
50 Wide Bargate, Boston,
Lincs PE21 6SA.

Camberwell
HEALTH AUTHORITY · LONDON

King's College Hospital

SENIOR PHYSIOLOGICAL MEASUREMENT TECHNICIAN

required for the Cardiac Department of this busy teaching hospital. The post is varied and challenging with responsibility for supervising junior staff and the opportunity to become involved in research. O.Tec/H.Tec level and three years relevant experience required including Catheterisation laboratory work.

Salary scale: £6795-£8249 pa inc.

Application form and job description available from:
Unit Personnel Department, King's College Hospital,
Denmark Hill, London SE5 9RS. Tel: 01-274 6222,
ext 2408.
Quoting Ref No UP/631.

Freshwater Biological Association

VACANCY FOR PHYSICAL LIMNOLOGIST AT WINDERMERE

Applications are invited for a three-year post in physical limnology, to work on exchanges of energy and matter across water-atmosphere and water-sediment interfaces and transport of dissolved and particulate matter in lake ecosystems. Potential candidates should possess at least a good honours degree in physics and/or mathematics and should ideally have some experience of environmental data collection and processing.

Salary and conditions of service are analogous to those of Scientific Officer (£5682-£7765) or Higher Scientific Officer (£7149-£9561) in the Civil Service, gross pay depending on qualifications and experience. Full details and application forms from the Secretary, Freshwater Biological Association, The Ferry House, Ambleside, Cumbria LA22 0LP (Tel 09662 2468). Closing date 24 February, 1984.

Inorganic Chemist

We are the leading UK manufacturer of Laboratory Chemicals and reagents and we now have a vacancy for a recently qualified CHEMISTRY or MATERIALS SCIENCE graduate in our Inorganic Development Research Department.

This Department carries out process development on a variety of chemicals for laboratory and industrial use, with special emphasis on materials for the opto-electronic industry.

Applicants should have a keen interest in practical chemistry and some knowledge of the role of inorganic materials in modern technology.

We can offer a competitive salary together with annual bonus, contributory pension scheme, subsidised staff restaurant and active social and sports club.

Applications in writing, with full curriculum vitae to: Mr J. M. Gordon, Personnel Officer, BDH CHEMICALS LTD, Broom Road, Poole, Dorset BH12 4NN.

BDH

TOPEXPRESS LIMITED

Scientific and Computer Consultants

RESEARCH SCIENTIST

We require a postdoctoral scientist with first class research experience to join a small team doing fundamental research in fluid mechanics. The work involves both theoretical and experimental studies of high Reynolds number flows.

Topexpress has been established for five years and now employs twenty scientists working on long-term research projects. Work to date has included active control of sound and vibration, structural acoustics, aeroacoustics and other wave phenomena. We provide an informal working environment in central Cambridge and we encourage publication of research findings. Salary is generous and negotiable.

Applications with a curriculum vitae and the names of two referees should be sent to Dr C. F. Ross, Topexpress Limited, 13/14 Round Church Street, Cambridge CB5 8AD.

Scientist

with electronics/instrumentation experience? Use your skills in a development role

around £10,000 South Bucks

This interesting post will suit an experienced graduate with a knowledge of instrumentation and electronics used in an industrial/scientific environment.

Based at our Amersham headquarters' laboratories, the successful candidate will play a key role in a team providing wide-ranging support to scientists and engineers developing new products, often in the health-care field. The work calls for liaison with scientists in many disciplines.

Candidates should be familiar with the principles of radiation detection and measurement, and should be capable of applying electronics and computers in a high-technology industrial environment. Experience of physical measurement, analytical instrumentation or the application of automation in chemical production would be advantageous. An innovative approach to problem solving, and an ability to lead other members of the team are essential.

Amersham International plc is a world leader in the supply of high technology products for use in medical diagnostics, industry and research.

Please write with a detailed c.v. to Mrs. Joan Cook, Personnel Department, at the address below.

Amersham International plc
White Lion Road Amersham
Buckinghamshire HP7 9LL

Amersham

Scientists

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If you want a career with a future, where you are rewarded according to your effort then consider selling. We have vacancies with major companies in medical/scientific equipment, pharmaceuticals and diagnostic reagents, throughout the U.K.

For a local interview to discuss an exciting future ring Sutcliffe Selection 0256 55955, (24 hours) 46/48 Essex Road, Basingstoke, RG21 1TB.

Sutcliffe Selection

SWATH Ships:

Hydrodynamic studies

(ref NA15-S)

Glasgow University Marine Technolgy Centre has a vacancy for a research assistant to work on hydrodynamic testing of **component resistance and scaling studies of multi-hull and SWATH ships** at wave-making speeds. Directed by Dr A. M. Ferguson, FRINA at the University's testing tank, the project would suit a researcher with a hydrodynamics background. Both experimental and theoretical work are involved. Further details are available from the address below ('phone 041-339-8855 X361 or 041-339-0969).

Starting salary will be on the range £6310-8975 depending on qualifiactions, experience and age.

Closing date: 2 March, 1984.

Applications, which should include a curriculum vitae and the names and addresses of two referees, should be sent to:

Project Administrator,
Marine Technology Office,
James Watt Building,
Glasgow University,
Glasgow G12 8QQ

Institute of Fisheries and Marine Technology

Applications or nominations are invited for this challenging position for an educational administrator with a strong scientific/technological background.

President

The Institute will occupy a new campus now under construction in St. John's, Newfoundland, adjacent to Memorial University's Scientific and Ocean Engineering facilities and to the National Research Council's Arctic Vessel and Marine Research Institute, and close to the Federal Government's Northwest Atlantic Fisheries Centre. The Institute will be an important part of the aggregation of facilities that makes St. John's a major centre for fisheries education and marine research in Canada and the leading Centre for Cold Ocean research.

Here is the foundation and opportunity to build a world class institute. Respond in confidence to Project 6166.

Toronto: (416) 920-7702. 64 Prince Arthur Ave. M5R 1B4
Montreal: (514) 849-5357. 1115 Sherbrooke St. W. H3A 1H3
Calgary: (403) 265-8780. 700-4th Ave. S.W. T2P 3J4
Vancouver: (604) 669-3550. 999 W. Hastings St. V6C 2W2

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THE UNIVERSITY OF ASTON IN BIRMINGHAM
Department of Mechanical and Production Engineering
RESEARCH ASSISTANT

Applications are invited from good graduate mechanical or production engineers for the above post to conduct research and development into the drawing of special and new non-ferrous alloys at elevated temperatures through new die materials, with new lubricants using new equipment. Opportunity may be available for submission for a higher degree.

The appointment will be for a period of three years, and the commencing salary will be within the range £6310 to £6745 pa. Employment prospects on completion of this contract are very good.

Application forms and further particulars may be obtained from the Staff Officer (quoting Ref: 591/32), University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET. Tel: 021-359 3611 Ext 4564. Closing date for the receipt of applications is 2 March, 1984.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE
Glasshouse Investigational Unit for Scotland

SENIOR HORTICULTURISTS

Applications are invited for two Horticultural posts on salary grade II.

SENIOR EXPERIMENTAL OFFICER—Post No 936

SENIOR HORTICULTURAL ADVISER—Post No 935

The Experimental Officer will take charge of the Development Programme at the Glasshouse Investigational Unit for Scotland and the Adviser will co-ordinate and participate in the provision of advice to growers in the West College Province.

Applicants should have horticultural, or other appropriate qualifications of at least degree standard and several years' experience of work relevant to the post in question. Applicants must hold a valid UK licence to drive a motor vehicle.

Salary: Grade II £10 907 rising to £13 599.

Further particulars (please indicate which post(s) are of interest) may be obtained fron the Personnel Officer, The West of Scotland Agricultural College, Auchincruive, Ayr KA6 5HW, to whom applications must be returned by 24 February, 1984.

BOEHRINGER INGELHEIM LIMITED

MEDICAL STATISTICIAN

Boehringer Ingelheim Limited is a part of a large international group which researches, develops, manufacturers and markets a wide range of pharmaceutical products.

We are seeking an experienced Medical Statistician to be primarily concerned with the company's clinical trials. In addition to advising on the statistical design of trials, clinical trials forms and carrying out statistical analysis of results, there will be close involvement with associated computer systems.

The ideal candidate will have degree or professional qualification in statistics with at least two years' experience working within the medical department of a pharmaceutical company. The person appointed will support the activities of our team of medical advisers and will report directly to the medical director.

We are situated in a pleasant, semi-rural part of South Berkshire, and provide excellent working conditions and staff benefits.

Interested applicants should write enclosing a curriculum vitae or telephone direct for an application form to:

The Personnel Department, Boehringer Ingelheim Limited, Southern Industrial Estate, Bracknell, Berkshire RG12 4YS. Tel: (0344) 424600.

PHARMACEUTICAL RESEARCH AND DEVELOPMENT

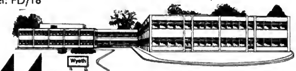
Wyeth Laboratories is a major international pharmaceutical company with a broad commitment to research and development to provide new products in the field of medicine and nutrition. Due to expansion of the Pharmaceutical Research & Development Department a vacancy has arisen in our solid dose formulation group to join an extremely active development team working on interesting new products, new formulations and new ideas.

Responsibilities include the development of oral tablet, capsule and novel dosage forms of new chemical entities and existing compounds. The work involves a wide span of activities ranging from physical pharmacy, biopharmaceutics, preformulation, formulation and stability. Project responsibilities extend into scale up studies, process development and transitional stages to full production.

This post is ideally suited for a graduate pharmacist or chemist with 2-3 years relevant experience, or a person with research experience who expects to gain a postgraduate qualification in the near future. Candidates should possess a sound knowledge of pharmaceutical technology, be well motivated, capable of demonstrating initiative and be able to communicate precisely and effectively. The post will also carry some supervisory responsibility for technical staff. Salary will be dependent upon age, qualifications and experience.

For an application form and further details please contact:—

Mrs. P. A. Thomas, Personnel Department, Wyeth Laboratories, Huntercombe Lane South, Taplow, Nr. Maidenhead, Berks. SL6 0PH
Tel: Burnham (06286) 4377 ext. 4342
Ref: PD/18



Wyeth Laboratories

NATIONAL INSTITUTE FOR BIOLOGICAL STANDARDS AND CONTROL
Division of Hormones
TECHNICIAN

We wish to recruit a graduate to join a group in the Phamacology Laboratory working on the isolation of biochemical characterisation of the endogenous peptides that mediate the effects, eg fever of bacterial endotoxin.

A sound knowledge and experience of techniques (eg chromatography, particularly HPLC, and immunological procedure) used for the purification of small quantities of biologically active polypeptides is necessary. Applicant should have a degree or equivalent in biochemistry or chemistry.

Salary is on a scale of £5491 to £7747, dependent on age, qualifications and experience, plus £1042 London Weighting.

Please write or telephone for an application form and further details to the Personnel Department, National Institute for Biological Standards and Control, Holly Hill, Hampstead, London NW3 6RB, telephone 01-435 2232.

Please quote reference no HO/058. Closing date for applications is 29 February.

EDITOR

Mazingira is an established international journal (6 issues per year) on environment and Third World development covering policy analysis, research, development and action on the environment; information about international environmental issues/events; and a section specifically designed to increase public awareness of the environment.

The publisher seeks an experienced magazine person, with scientific background and sound creative writing ability, capable of adapting texts from a wide range of sources to a style appropriate to the journal's audience, who will be expected to assist in the commissioning of articles and thus establish a wide range of contacts at the highest level. He/she will be responsible for all aspects of production prior to printing.

Location: Dublin, Ireland, or Oxford, UK. Salary and terms negotiable.

Apply in writing in first instance, enclosing cv and samples of work, if appropriate to: **Mr A. Harris, General Manager, Tycooly International Publishing Ltd, 6 Crofton Terrace, Dun Laoghaire, Co. Dublin, Ireland.**

OXFORD UNIVERSITY
Physical Chemistry Laboratory
POST DOCTORAL RESEARCH ASSISTANT

Applications are invited for an SERC funded appointment to work with Dr R. P. Wayne on investigations of reactive gases and radical species of atmospheric importance. The research is a collaborative programme between the Physical Chemistry Laboratory (PCL), Oxford and the Rutherford Appleton Laboratory (RAL), situated some 15 miles south of Oxford. The succesful applicant will divide his time between Oxford, where he will investigate sources of the radicals, and RAL, where he will bring chemical skills to a team of atmospheric physicists carrying out high resolution Fourier spectroscopy. A major objective of the studies is the interpretation of upper atmospheric data obtained from balloons, rockets and satellites.

The assistantship is for three years, commencing as soon as possible at a starting salary of up to £8530 with membership of USS.

Applications with CVs and the names of two referees should be sent to Dr R. P. Wayne, Physical Chemistry Laboratory, South Parks Road, Oxford OX1 3QZ.

INFORMATION OFFICER

Horsham, West Sussex

A vacancy has arisen for an experienced Information Officer to join the Information Services Unit at our Headquarters in Horsham.

The Unit provides medical and scientific information services in-house to our medical, marketing and R&D departments, and also externally to members of the medical profession.

Duties will include enquiry answering, literature searching using both manual and on-line systems, and current awareness services.

This post will suit a life science graduate, particularly pharmacology or pharmacy, with 2-4 years experience in medical/scientific information work, ideally in the pharmaceutical industry.

We offer an attractive salary, and the first class benefits one would expect from a leading company within the pharmaceutical industry.

To apply, please write giving brief details of age, qualifications and experience to:
Miss S.J. Byrne, Personnel Officer,
Ciba-Geigy Pharmaceuticals Division, Horsham, West Sussex RH12 4AB.

CIBA–GEIGY

Analyst/Programmer

for development of R & D Information Systems

The Wellcome Research Laboratories are looking for an experienced **ANALYST/PROGRAMMER** to join a small team designing and developing database systems for scientific information. Knowledge of COBOL, together with some experience of systems design will be of advantage. You will also need the ability to communicate at all levels with user Departments and have the potential for progression. Where necessary training in analysis and database techniques will be provided.

The Company operates IBM 4341 and 3033 computers using VM/CMS and MVS operating systems. There is a large communications network serving several sites in the UK.

Salary will be in the range £9000 to £10 000 depending on experience and potential. Less experienced applicants may be considered on a lower salary scale.

The Laboratories are situated in pleasant parkland surroundings within easy reach of Central London. Excellent benefits include five weeks' holiday annually, Company persion fund, sick pay scheme, subsidised canteen and assistance with re-location expenses where appropriate.

For an application form, please ring our automatic telephone answering service on 01-650 6541, giving your name, address and telephone number and quoting reference WRL/253 or write to Miss E. M. Josset, Personnel Officer, The Wellcome Research Laboratories, Beckenham, Kent BR3 3BS.

Wellcome

WANDSWORTH HEALTH AUTHORITY

Atkinson Morley's Hospital
Department of Medical Physics

ELECTRONICS TECHNICIAN

A Technician is required to design, build and develop microprocessor based instruments including both associated hardware and software.

The person appointed will join a small team of scientists and technologists providing a service to Atkinson Morley's Hospital and to other Hospitals in the District and Region.

Educational standard will be to at least H-TEC or HNC with a minimum of five years appropriate experience, including work with microprocessors. The appointment will be in the grade of Medical Physics Technician II.

The starting salary will be £8009, with increments up to a maximum of £9835 including London Weighting. Post available from April, 1984.

For further information please contact Ian Eversden, Principal Physicist.

Application form and job description available from Hospital Administrator, Atkinson Morley's Hospital, Copse Hill, Wimbledon, London SW20. Tel: 01-946 7711.

CRANFIELD

RESEARCH ASSISTANT

for work on planetary gear-trains. The aim of this SERC-supported project is to investigate and develop a design code for large two-stage and three-stage planetary gear-trains with reversing facilities, having particular regard to marine applications. There will be opportunity for technical collaboration with Allen Gears (part of the NEI-APE Group).

The work, which is theoretical, should be suitable for a PhD thesis.

Previous experience with gearing is not essential. Candidates should have a background in engineering and/or mathematics, the ability to think logically from first principles and a preference for working in a small, informal group.

For an application form and further information, please contact: The Personnel Department, Cranfield, Institute of Technology, Cranfield, Bedford MK43 0AL. Tel Bedford (0234) 750111, Ext 3336.

ST MARY'S HOSPITAL MEDICAL SCHOOL
(University of London)
Norfolk Place, London W2 1PG
Academic Surgical Unit

MEDICAL LABORATORY SCIENTIFIC OFFICER

Applications are invited for the post of Basic Grade MLSO in the above department which has research interests in surgical metabolism, wound healing and animal models in disease. The work is biochemically orientated and a knowledge of HPLC and animal experimentation would be advantageous.

Those with degrees would have no opportunity to study for a PhD with this post.

Starting salary £7413-£7747 plus London Allowance.

Further information from Miss Jose Biglin, Academic Surgical Unit, at above address, Tel No (01) 723 1252 Ext 46.

Applications with cv and names and addresses of two referees to be made to: Assistant Secretary (Personnel) at above address by 29 February.

Teratologists

Huntingdon Research Centre is the largest contract research organisation in Europe, involved in the biological safety evaluation of pharmaceutical, agricultural and general industrial chemicals. Because of business growth, we require additional Teratologists to supplement our existing team of internationally recognised scientists who are leaders in their field.

It is essential that candidates should be experienced in the evaluation of foetal changes in the species of animals normally used to assess the safety of new medicine, food additives and pesticides. The successful applicant will have a degree, or equivalent qualification, in the biological sciences and preferably some five years relevant practical experience in an industrial situation.

In return we offer a competitive salary with a full range of benefits and assistance with relocation.

Please write giving full details of experience, qualifications and expected salary to:
Mrs. Nancy McCree, Personnel Officer, Industrial and Environmental Studies Division, Huntingdon Research Centre, Huntingdon PE18 6ES,
phone 0480 890431, extension 3251.

Closing date for receipt of applications:
17th February, 1984.

HRC

Huntingdon Research Centre plc

CLINICAL TRIALS OFFICER

Due to an expanding research and development programme, Lundbeck Limited has further vacancies for Clinical Trials Officers to undertake pre- and post-marketing clinical trials in the UK and Ireland.

Applicants should be qualified in pharmacy, pharmacology, biochemistry or biology. The essential requirement is experience in the design, planning, arrangements and follow-up of clinical trials, both in the GP and hospital setting. Preference will be given to applicants with experience of clinical trials, particularly in psychopharmacology.

It is envisaged that suitable candidates will be 25-35, enthusiastic, with a sound professional outlook. The salary offered is negotiable depending on experience, and a Company car will be provided. The positions will be based at our offices in Luton.

Additional benefits include free BUPA, life, personal accident and permanent health insurance; a first-class pension scheme and four weeks annual holiday (rising on service).

Write or telephone in confidence for an application form to:

Lundbeck

Liz Ledster
Lundbeck Limited
Lundbeck House
Hastings Street
Luton, Beds LU1 5BE
Telephone: Luton (0582) 416565.

UNIVERSITY COLLEGE OF SWANSEA

Chair of Mechanical Engineering and Headship of Department

Applications are invited for the Chair and Headship of the Department of Mechanical Engineering from October 1, 1984.

Further particulars may be obtained from the undersigned, University College of Swansea, Singleton Park, Swansea, SA2 8PP, to whom applications (15 copies) should be sent by *March 16, 1984.*

V. J. Carney
Registrar

MEDICAL RESEARCH COUNCIL
CLINICAL PHARMACOLOGY UNIT

UNIVERSITY DEPARTMENT OF
CLINICAL PHARMACOLOGY
RADCLIFFE INFIRMARY
OXFORD OX2 6HE

TECHNICIAN

required for a research project concerned with the neuro-chemistry and neuro-pharmacology of antidepressant drugs with emphasis on the mechanism of action of electroconvulsive theraphy

Applicants should have HNC, degree or equivalent qualifications. Familiarity with biochemical techniques would be an advantage

Salary will be within the range £5491–£7747

Applications, with the names and addresses of two referees, should be sent to Mr J. A. Rose at the above address by 20 February, 1984

Toxicology Technicians

Stock, Essex
c.£5,500-£7,500

As part of continual expansion, Beecham Pharmaceuticals has acquired a new larger site at Stock, near Chelmsford.

Applications are invited from Toxicology Technicians with experience of animal dosing for a number of vacancies in the Toxicology Department.

Aged at least 18, you will possess a knowledge of routine toxicology procedures and ideally an appropriate formal qualification such as IAT.

Day release opportunities for further study will be provided.

For an application form please write to the Personnel Department,
Beecham Pharmaceuticals Research Division,
Honeypot Lane, Stock, Essex CM4 9PE
quoting reference 1/84.

Beecham
Pharmaceuticals

RSPB

The Royal Society for the Protection of Birds

ASSISTANT REGIONAL OFFICER (WALES)
(Based at RSPB Wales Office, Newtown, Powys)

A second ARO post to supplement the work of the Regional Officer, an existing Assistant and a Reserves Manager (Wales).

Duties. assist generally in representing RSBP in Wales, with emphasis on

- (a) liaison with statutory and other voluntary bodies on conservation matters.
- (b) Supervision of seasonal contract workers on survey, census and management work.
- (c) Aspects of species protection work.

Applicants (age 30-40) must have sound bird knowledge and academic ecological/biological training; should be confident in debating conservation issues. Much travel involved. Welsh speaker prefered

Salary range £6297-£9516 × 12 increment (under review from 1 April, 1984)

For details and application form send sae to Personnel, The Lodge, Sandy, Bedfordshire SG19 2DL

A Bigger Career Choice in Medical Sales

If you have a scientific or paramedical background and want to succeed in a commercial environment leading to a managerial role, then phone Andree Osborne or Alistair Ross now on 01-222 1547.

Ross Warren Recruitment

Design Engineer

Current prospects in circuit design

IBM United Kingdom Laboratories Limited at Hursley, about five miles from Winchester in Hampshire is one of the Corporation's largest development facilities in Europe.

We are looking for an additional Design Engineer, male or female, to work on linear and analogue circuit design to be integrated on single silicon chips for use in computer peripherals.

Essential requirements should include:

- A good honours degree in Electronics, Physics or Electrical Engineering.
- Experience in Computer Aided Design techniques.
- Enthusiasm for fundamental circuit design.
- Sound knowledge of semi conductor physics.
- Keen interest in detailed circuit design, eg. amplifiers, phase locked loops and control systems at the silicon level.

IBM United Kingdom's extensive benefits package includes an excellent salary, flexible working hours, free life assurance, contributory pension scheme and BUPA membership. Relocation assistance to this attractive part of Hampshire will be provided where appropriate.

If you can meet the requirements and wish to consider joining an exciting and dynamic team, contact Ron Stotter, Personnel Officer, for an application form, at IBM United Kingdom Laboratories Limited, Hursley Park, Winchester, Hants. SO21 2JN. Please quote ref: **NS/7566**

- 15,000 jobs in over 40 UK locations
- Two manufacturing plants
- Development laboratory near Winchester
- An equal opportunity employer
- £522 million exports in 1982
- £119 million invested in UK in 1982

IBM

Medical Information Executive

Pharmaceuticals – Welwyn Garden City

Roche Products Ltd is a major international pharmaceutical company with a fast expanding research programme directed at developing new drugs in several important areas of health care. The emphasis is very much on growth and a new division has recently been established to increase company capacity still further.

At our Head Office in Welwyn Garden City, we are now looking for a highly experienced Information Executive to be responsible to the Head of Medical Information for providing a comprehensive range of information for the medical and allied professions, and within the Company. This will cover ethical products in certain areas of medicine and therapeutics and the person appointed will, in effect, become the expert in those areas.

We are looking for a man or woman with a degree in Pharmacy or a Life Science, together, ideally, with some experience of information work, preferably in the pharmaceutical industry. An ability to communicate fluently both verbally and in writing is essential together with skill in writing literature, checking and writing creative advertising copy.

The appointment carries a highly competitive salary and an attractive range of benefits including pension fund, free life assurance, 24 days' holiday, Christmas award, subsidised restaurant and free BUPA.

Write or telephone for an application form to Mrs Judge, Personnel Officer, Roche Products Limited, PO Box 8, Welwyn Garden City, Herts AL7 3AY. Telephone Welwyn Garden 28128 ext 2129.

ROCHE

DURHAM UNIVERSITY

Department of Applied Physics and Electronics

Applications are invited for the post of

CAD OFFICER FOR VLSI DESIGN

The post is associated with the SERC supported MEng/MSc course in IC design given in Durham. The Officer will be expected to become expert in the use of the growing range of electronics CAD packages and IC test facilities provided by SERC and to support and develop their use locally.

Candidates should preferably have some postgraduate or industrial experience of VLSI design and/or electronics CAD. The post is tenured and it may be possible to work for a higher degree.

Salary will be on the Experimental Officer scale £6310-£11 615 plus superannuation.

Applications (three copies) naming three referees should be sent by 29 February, 1984 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

TOPEXPRESS LIMITED

Scientific and Computer Consultants

seeks

PROGRAMMERS

to join a team working on compilers, operating systems and other system software for a variety of computers. The successful candidate is likely to be a Computer Science graduate with a practical approach to problem solving. Flexibility and enthusiasm are more important than any specific experience.

Topexpress has been established for five years and employs 35 full time staff. The company is based in central Cambridge and offers an informal working environment with good benefits including profit sharing, personal health insurance and a pension scheme.

Applications should be made in writing with a curriculum vitae and the names of two referees to:

Dr R. D. Evans
Topexpress Limited
13/14 Round Church Street
Cambridge CB5 8AD

UNIVERSITY OF WARWICK

RESEARCH TECHNICIAN

In the Developmental Biology Group of the Department of Biological Sciences, to work on the analyses of gene activity in the developing embryo. The work involves the use of modern recombinant DNA techniques. Applications are invited from graduates and others with appropriate qualifications in bio-chemistry and/or microbiology. The post is for a contract period to December, 1985. Salary on the Technician Grade 3 scale: £5151-£6035 pa. Application should be made by letter giving full details of age, qualifications and experience quoting Ref No: 26/T/84/F, to the Personnel Office, University of Warwick, Coventry CV4 7AL by 16 February, 1984.

ENVIROTEST. A scientific consultancy company seeks a Qualified Individual with practical experience to carry out consultancy work. Good opportunities, salary negotiable. CV to: Envirotest Ltd, 223 Hatfield Road, St Albans, Herts.

THE UNIVERSITY OF MANCHESTER/ DARESBURY LABORATORY

Synchrotron Radiation—Post Doctoral Posts in X-Ray Spectroscopy

Re-advertisement

Applications are invited for two positions funded by SERC, tenable from as soon as possible for two years in the first instance. One post is concerned with research at the Synchrotron Radiation Source at Daresbury and the successful candidate would be responsible for the development and commissioning of a fluorescence detector facility on the X-Ray Spectroscopy Station on the Wiggler beam line. The second post is in connection with the recently established EXAFS service at Daresbury, which is designed to enhance the applications of EXAFS techniques to the study of chemical and biochemical systems. Applicants are expected to hold a PhD in Physics, Chemistry, or a Biological Science. Experience in instrumentation and/or computation would be advantageous. Salary range pa: £7190-£11 615 (Superannuation).

Applications, with full cv and the names of two referees, to either

Dr C. D. Garner, Chemistry Department, University of Manchester, Manchester M13 9PL or Dr S. S. Hasnain, Daresbury Laboratory, Warrington WA4 4AD
by February 21, 1984.

Pharmacologist

Huntingdon Research Centre is the largest contract research organisation in Europe involved in the biological safety evaluation of pharmaceutical, agricultural and general industrial chemicals.

We require a Pharmacologist in the Department of Pharmacology to join a team undertaking the pharmacological evaluation of nevel compounds for a wide variety of activities.

Applicants should have a degree in Pharmacology or Pharmacy and one to two year's industrial experience preferably in biochemical and/or CNS pharmacology, would be an advantage.

Starting salary would be dependent upon experience. We offer excellent benefits with relocation assistance, if required. The Centre is located in pleasant countryside with excellent road and rail links to Cambridge, London and the Midlands.

Please apply in writing with full c.v. to
Nancy McCree, Personnel Officer,
Industrial and Environmental Studies Division,
Huntingdon Research Centre,
Huntingdon PE18 6ES,
phone 0480 890431,
extension 3251.

HRC

Huntingdon Research Centre

MICROCOMPUTER SYSTEMS FOR LABORATORIES

We need staff to join our team, marketing an expanding range of microcomputer based systems and software to scientific laboratories. A background in science or engineering and some knowledge of microcomputer hardware are important. Sales experience helpful but not essential. A company car is provided and regular travel is involved. Remuneration is by salary without commission.

Please write with details of your career to date, to the Director of Marketing, Heyden Datasystems, Spectrum House, Hillview Gardens, London NW4 2JQ.

GLASGOW UNIVERSITY
Department of Botany
GRADE 6 ELECTRON MICROSCOPE TECHNICIAN

An experienced Electron Microscope Technician is required for the Garscube Laboratories. The successful applicant will be responsible for the supervision of the technicians at the Laboratory as well as being responsible for providing an EM service for the whole Department. HNC or equivalent qualification with 9-10 years experience. Salary range £7202-£8602.

Applications giving the names of two referees, should be sent to Professor M. B. Wilkins, Department of Botany, Glasgow University, Glasgow G12 8QQ, as soon as possible but no later than Monday, 26 February, 1984.

In reply please quote Ref. No. 5194N.

Cranfield

Silsoe College

A new Chair in support of the food production industry

Applications are invited for a new Chair at Silsoe College, Cranfield Institute of Technology. This Chair will be the first appointment leading to the establishment of a strong, research-based group in support of the food industry in Britain.

Preference will be given to applicants who are recognised authorities in a particular field of science relevent to food production. The successful candidate will be capable of forming and leading a multi-disciplinary team undertaking a balance of fundamental and applied research supported by industrial and other food sector sponsors.

The programme of work may be concerned with the development of a better understanding of the nature and properties of food raw materials and their inter-relationships. Work may also be undertaken on the synthesis of more cost-effective food manufacturing processes through improved engineering or food design.

For further particulars please contact: The Personnel Department, Cranfield Institute of Technoloogy, Cranfield, Bedford, MK43 0AL. Telephone: Bedford (0234) 750111 Ext 3336.

Closing date for applications: 12 March, 1984.

WELSH NATIONAL SCHOOL OF MEDICINE (University of Wales)

DEPARTMENT OF CARDIOLOGY

POSTDOCTORAL RESEARCH OFFICER

Applicants with experience in physiology/pharmacology are invited to apply for a 3-year post (subject to a probationary period) to join a small research team working on control mechanisms in vascular smooth muscle, with particular reference to the role of endothelium. Individual initiative will be encouraged within this area.

Sarting salary for suitably qualified candidates could be up to £8530 on the Scale for University Research and Analogous Staff Grade 1A. Applications in the form of a curriculum vitae with names and addresses of two referees should be sent to the Registrar and Secretary, Welsh National School of Medicine,Heath Park, Cardiff, CF4 4XN (quoting ref. No. C15/2/31) one month from the date of appearance of this advertisement.

Further information from Dr Malcolm Lawia (0222/755944 Ext. 2066 or 2058).

GUY'S HOSPITAL

CYTOGENETICIST (BASIC GRADE SCIENTIFIC OFFICER)

Applications are invited for the post of Basic Grade Cytogeneticist. The Centre provides a diagnostic cytogenetics service, including prenatal diagnosis to the SE Thames Region. Practical experience in cytogenetics would be an advantage, but graduates in Biology or Genetics could be given training in this post.

Salary: £6723-£9391 pa (depending on experience)

For further information and an application form please contact the Personnel Officer, Guy's Hospital, St Thomas Street, London SE1 9RT. Tel 01-407 7600 Ext 3471 Quoting Ref: P/3.

Closing date for completed applications: 29 February, 1984.

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CANCER RESEARCH CAMPAIGN

Normal Tissue Radiobiological Research Group
Churchill Hospital
Oxford

Vacancies exist for an

ELECTRONICS TECHNICIAN

and a

RESEARCH TECHNICIAN

to work in an expanding cancer research group. The technicians appointed will be required to assist in a wide range of interesting research projects

The electronics technician would be encouraged to design, construct and maintain various items of specialised equipment. The appointment would be on scale III or IV for Medical Physics Technicians, salary in the range of £5552-£6588 pa depending on qualifications and experience.

The research technician should have an interest in biological sciences and experience in histology and/or cell culture techniques would be and advantage but not essential. This appointment would be on the scale for Medical Laboratory Scientific Officers (salary range £5491-£6436 pa)

Qualifications for both posts, ONC, HNC or equivalent. The successful candidates would be expected to show a degree of self-motivation although guidance and training with specific techniques would be given.

Further information from Mrs. B. Whitehouse, Oxford 64841 extension 548 or Mr D. Wallington extension 637. Applications to the Director of Radiobiological Research, Research Institute, Churchill Hospital, Oxford, with the names of two referees, by 29 February, 1984.

Brighton Health Authority

ROYAL SUSSEX COUNTY HOSPITAL

MEDICAL PHYSICS TECHNICIAN (2)

(Nuclear Medicine)

Applications are invited for the above post in the Medical Physics Department.

The successful candidates will be concerned with the provision of the Nuclear Medicine Service to the Brighton Health Authority.

Previous experience in radio-isotope organ imaging and radioisotope procedures is essential. A knowledge of data processing and computer techniques would be an advantage.

Salary £7386 pa rising by 8 annual increments to £9212 pa.

Informal visits welcome.

Application forms obtainable from the Unit Personnel Officer, Royal Sussex County Hospital, Eastern Road, Brighton BN2 5BE. Tel. Brighton 606611 Ext. 106.

QUEEN MARY COLLEGE
University of London

GRADUATE RESEARCH ASSISTANT

Applications are invited for an SERC-funded post for investigation of archaeological pottery by multi-element analysis using inductively-coupled plasma emission spectrometry. The project involves collaboration between Mr R. P. Symonds, Colchester Archaeological Trust, Dr J. N. Walsh, King's College, and Dr F. A. Hart, Queen Mary College. Candidates should ideally be chemistry, geochemistry or geology graduates with some knowledge of computing and a strong interest in archaeology. Appointment for one year with salary range £7496-£7931 pa.

Further details available from The College Secretary, Queen Mary College, Mile End Road, London E1 4NS, to whom application should be made by letter enclosing curriculum vitae and names of two referees.

M.R.C. CLINICAL RESEARCH CENTRE
(Northwick Park Hospital)
WATFORD ROAD, HARROW
MIDDX HA1 3UJ

APPLIED IMMUNOCHEMISTRY RESEARCH GROUP

Applications are invited from science or medical graduates for a 3 year postdoctoral position to participate in studies of the structure and function of glycoprotein and glycolipid markers of human tumours and leukemic cells detected by monoclonal antibodies. The work will be carried out in a research group (Head of group Dr. Ten Feizi) which is well equipped for immunochemistry and carbohydrate bio-chemistry. A strong background in bio-chemistry is desirable.

Salary scales are related to those for university non-clinical academic staff and the NHS for clinically qualified candidates. Salary on appointment will depend on age and experience.

Application forms and further details may be obtained by writing to Miss J. Cottam, Personnel Dept. Quoting ref. 10B/1/3784.
Closing date for applications 2 March, 1984.

THE UNIVERSITY OF BRITISH COLUMBIA

GRADUATE STUDIES IN CHEMISTRY

Applications invited from candidates with high academic records who wish to pursue further studies towards the MSc and PhD Degrees in Chemistry. Excellent research facilities are available in all areas of modern Chemical Science ranging from Biological Chemistry to Chemical Physics. Teaching and research assistantships are available for all students in the programme. Stipends up to $20 800 are available to highly qualified students who hold scholarships; the minimum stipend for 1983-84 is $11 000.

Application forms and further particulars may be obtained from: Dr L. Weiler, Professor and Head, Department of Chemistry, The University of British Columbia, 2036 Main Mall, Vancouver, BC, Canada V6T 1Y6.

POSTGRADUATE RESEARCH IN ZOOLOGY

Various projects are available for research leading to PhD or MSc degrees, in fields ranging from cellular to environmental levels and covering pure and applied Zoology. Some Studentships are available each year on a competitive basis. For further information please write to: The Secretary, Dept of Zoology, University College, Cardiff CF1 1XL.

THE UNIVERSITY OF MANCHESTER

RESEARCH ASSOCIATES (TWO) IN THE DEPARTMENT OF ORAL AND MAXILLO-FACIAL SURGERY

Applications are invited for these two posts for an initial period of three years, to undertake research in laboratories within the Department of Pharmacology. Applicants should have experience in either electrophysiology or microvascular pharmacology. Initial salary range pa: £7190-£8530. Superannuation. Further details and informal visits by contacting Professor J. P. Rood, Department of Oral and Maxillo-facial Surgery, Turner Dental School, Higher Cambridge Street, Manchester M15 6FH (061-273 5252). Applications, with a curriculum vitae and the names of two referees, to be submitted by 5 March.

UNIVERSITY OF LEEDS

RESEARCH TECHNICIAN
Grade 3

required for an SERC funded project on protein phosphorylation in photosynthesis. The work will involve assisting with 32P–labelling and gel electrophoresis of chloroplast membrane proteins, fluorescence spectrometry and general laboratory duties under supervision. The post is available for three years from 1 April, 1984. Applicants should be qualified to at least ONC or equivalent level and have had at least three years laboratory experience. Salary on the scale £5151-£6035. Applications should include a full cv and be sent to Dr J. F. Allen, Department of Plant Sciences, Baines Wing, The University, Leeds LS2 9JT by 15 February, 1984. Further information is available on request. Telephone (0532) 43151, ext 6580.

UNIVERSITY OF WARWICK

POSTDOCTORAL RESEARCH FELLOW IN MOLECULAR VIROLOGY

In the Department of Biological Sciences to work on a project funded by the European Economic Community. The work will be concerned with the application of recombinant DNA techniques to the study of Rotaviruses. Salary will be on the Research IA scale: £7190-£11 615 pa. The position is available from 1 April, 1984 for an initial period of two years. Further information can be obtained by telephoning Dr M. A. McCrae on Coventry (0203) 24011, Ext 6024. Applicants should send a cv with the names and addresses of two referees to the Executive Officer, Department of Biological Sciences, University of Warwick, Coventry CV4 7AL, quoting reference MAM/NAR. Closing date 27 February, 1984.

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Your science degree, laboratory background, or 'A' levels could help you become a medical/scientific representative. Many vacancies for trainees exist throughout the UK with excellent salaries + car + benefits. 'Phone or write (no stamp needed), for your copy of our information leaflet to Colin Mackinnon.

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The Institut Laue-Langevin, situated in Grenoble, France, is a research centre run jointly by the UK, France and Germany, where scientists use neutron beams generated by a high flux nuclear reactor to carry out fundamental studies in physics, biology and chemistry.

We now have a small number of vacancies for:

Scientists for research using neutron beams

The Institut regularly recruits scientists for periods of up to five years. The principal role of such scientists is to assist in the full exploitation of the high flux neutron source, particularly bearing in mind the requirements of approximately 1700 visitors each year. There is a heavy involvement in the design and operation of instruments and in scientific collaboration as well as independent research. The fields of activity include theoretical physics, solid state physics, nuclear physics, crystallography, the liquid and amorphous state, chemistry and biology. Successful applicants, who may be on a secondment from a home Institute, will normally have had some neutron experience but outstanding applicants from related fields will also be considered.

Senior Scientists in fundamental or nuclear physics

A senior appointment will be made in 1985 to supervise instruments in the field of nuclear fission, nuclear structure and fundamental physics. The person appointed will be expected to carry out research in one of these fields and the Institut would at this time like to encourage studies in fundamental physics. The appointment will be for three to five years for a scientist on secondment from a University or Institute.

Post-Graduate research studentships

Post-Graduate positions are available at the Institut to enable exceptional students to benefit from its unique facilities for neutron beam research. UK applicants wishing to carry out post-graduate studies would normally be expected to hold a first-class graduate honours degree but studentships may also be held by students who have already completed part of their doctoral programme and have demonstrated a marked aptitude for research. In all cases students will be supervised by both a member of staff from a home University and an ILL scientist.

Applications in writing to:
The Director, Institut Laue-Langevin,
Avenue Des Martyrs, 156X, 38042
Grenoble, Cedex, France

institut laue langevin
grenoble france

DURHAM UNIVERSITY

LECTURESHIP IN PHYSICS

Applications are invited for a Lectureship in Physics tenable from 1 October, 1984 under the SERC Special Replacement Scheme to enable the University to appoint an outstanding young researcher to a tenured post. The successful applicant will be expected to contribute to undergraduate and postgraduate teaching, particularly in the field of Solid State Physics, and to become actively involved in experimental research on Magnetism for which excellent facilities exist.

Salary on the scale £7190-£14 125 with superannuation.

Applications (three copies) naming three referees should be sent by 29 February, 1984 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom particulars may be obtained.

THAMES POLYTECHNIC

School of Biological Sciences and Environmental Health

TECHNICIAN GRADE 4

The successful applicant will take responsibility for the day to day organisation of a microbiology teaching laboratory including the provision of materials for classwork. Assistance in the School's other laboratories may be required. Applicants should hold an ONC or OND in Science, or GCE passes, including two at 'A' level, or equivalent qualification plus relevant working experience.

Salary scale: £6326-£7202 inclusive

Further particulars and application form from the Staffing Officer, Thames Polytechnic, Wellington Street, London SE18 6PF, to be returned by 21 February, 1984.

Thames Polytechnic is an equal opportunities employer.

UNIVERSITY OF CAMBRIDGE

Department of Physical Chemistry

POSTDOCTORAL POSITION

available for research into the structure and reactivity of materials in the Bi-Mo-W-oxide system. Techniques to be used include X-ray and electron diffraction, X-ray emission and electron energy loss spectroscopy, and high resolution electron microscopy. Applicants must have some experience in crystallographic studies of oxides.

The appointment will be for one year in the first instance, with possible renewal for a second year. Applications, with cv and names of two referees, to Dr D. A. Jefferson, Department of Physical Chemistry, Lensfield Road, Cambridge CB2 1EP, no later than 20 February, 1984.

UNIVERSITY OF NOTTINGHAM

School of Agriculture

RESEARCH ASSISTANT IN REPRODUCTIVE PHYSIOLOGY

A post-doctoral Research Assistant is required for a period of 18 months to study the use of milk temperature measurements as an aid to oestrus detection in dairy cattle. Applicants should have a higher degree in Animal Physiology, or a related subject, and should have computing experience.

Applications, including a full cv and names of two referees should be submitted to Prof G. E. Lamming, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough, Leics. LE12 5RD from whom further written details of the post can be obtained.

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Please write with full c.v. to the Personnel Manager (AB), at the address below or telephone Little Chalfont (02404) 4444.

Amersham International plc
White Lion Road Amersham
Buckinghamshire HP7 9LL

Amersham

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
Microbiology Department
A RESEARCH SCIENTIST
is required to devise and develop new rapid methods for estimating the bacteriological quality of milk, milk products and other foods. The further development and automation of the direct epifluorescent filtration technique (DEFT) is envisaged. Additionally, the application of radioimmune, ELISA, and allied techniques for food analysis will be explored.

Appointment will be as Scientific Officer (£5682-£7765) or Higher Scientific Officer (£7149-£9561). Non-contributory superannuation. Candidates should have a First or Upper Second Class Honours degree in biological or physical sciences with at least two years' relevant post-qualifying experience for appointment as HSO.

Applications to the Secretary, NIRD Shinfield, Reading RG2 9AT. Please quote reference 83/19.

EUROCAT
EEC research project at University of Louvain in Brussels
BIOLOGIST
with computing experience to work with epidemiologists in managing and analysing birth defects data bank. English and French essential, German or Italian an advantage.

Post is available immediately for at least two years. Salary scale £6000 to £8000, negotiable.

Apply, sending curriculum vitae and names of three referees, with addresses, to: Project Leader, Eurocat, EPID 30:34, Clos Chapelle Aux Champs 30, B-1200 Brussels, Belgium.

PYRENE

SPECIALISED EQUIPMENT DEVELOPMENT ENGINEER

Pyrene Chemical Services Ltd, a member of the Brent Chemicals International group of companies and the leading UK supplier of metal pretreatment chemicals, has a vacancy in the Product Development Laboratory at Iver, Buckinghamshire, for a Specialised Equipment Development Engineer.

The successful candidate will probably be aged 21-30 and qualified to HND level or equivalent in electronics, with preferably a knowledge of chemistry to at least GCE 'O' level standard. He/she will be primarily involved with carrying out feasibility studies on new product lines, design liaison with sub-contractors, quality control on incoming equipment and troubleshooting, repair and calibration of chemical pretreatment process controllers both in the laboratory and on site (mainly in the UK but occasionally abroad).

It is anticipated that the successful applicant will have had practical experience in the repair to component level of analogue and digital circuitry and be able to modify circuitry and design new printed circuit boards to enable the automatic controllers to match the requirements of new processes developed in the laboratories. Experience with industrial process controllers, particularly those using conductivity sensors, will be an advantage but is not essential.

The laboratories are modern, well-equipped and situated in pleasant surroundings. BUPA membership, subsidised restaurant and active social club are among the fringe benefits offered.

Please write or telephone for application form to:
Mrs M. Swinburne,
Brent Chemicals International PLC,
Ridgeway, Iver, Bucks SL0 0HT.
Tel: Iver 651812.

TECHNICAL CHANGE CENTRE
PRINCIPLE
RESEARCH FELLOWS
The Centre is seeking to appoint full-time Principal Research Fellows to work on research projects concerned with (a) the careers of graduate scientists and engineers and (b) the contribution which British academic research makes to the advancement of UK engineering. Applicants should be graduates in science or engineering, or have other relevant qualifications, and have experience of inter-disciplinary research studies. The appointments will be for two years in the first instance. Salaries will be not less than £15 000 pa, depending on qualifications and experience

Applications in writing together with a full CV, should be sent to the Secretary, The Technical Change Centre, 114 Cromwell Road, London SW7 4ES from whom further particulars may be obtained.

UNVERSITY OF LEICESTER
Department of Physics
LECTURESHIP IN CONDENSED MATTER PHYSICS
Applications are invited for a Lectureship in the Department of Physics tenable immediately. Applicants, who must normally be under 35 at the time of appointment, should have research interests in experimental condensed matter physics. Preference will be given to persons who have experience in the fields of luminescence, spectroscopy, photoemission or electrical properties of solids and who have interests in amorphous semiconductors and metals, surfaces or interfaces.

Initial salary will depend on qualifications and experience on the Lecturers' Scale £7190 to £14 125.

Further particulars from the Registrar, University of Leicester, University Road, Leicester LE1 7RH, to whom applications should be sent on the form provided by 31 March, 1984.

UNIVERSITY OF GLASGOW
Departments of Cell Biology and Electronics & Electrical Engineering
A CELL BIOLOGIST
with PhD who has a strong interest in cell interactions and a practical knowledge of Electron Microscopy or/and Cell Culture is required for work on a project on the reaction of nerve cells in culture to micro-engineered surfaces. The project is funded by SERC. The project is directed jointly by Professor C. Wilkinson of the Department of Electronics and Electrical Engineering and Professor A. Curtis, Department of Cell Biology. The appointment will be initially for one year. It is hoped that the successful applicant will be able to take up the post from the end of February. Starting salary will be within £7190-£8530 on Range 1A of the salary scales for Research and Analogous Staff.

Enquiries and applications to Professor A. Curtis, Department of Cell Biology, University of Glasgow, Glasgow G12 8QQ (Tel 041-339 8855, Ext 7147).

In reply please quote Ref No 5195N.

SHERKIN ISLAND MARINE STATION

Volunteers required for serious research April-Oct. 1984. Surveys, seashore monitoring, phytoplankton (red tide), zooplankton, bird watching, benthos, diving. Full board offered and £5·00 weekly pocket money.

Write with C.V. to: Sherkin Island Marine Station, Sherkin Island, Co. Cork, Ireland. Phone (028) 20187

**ROYAL MILITARY COLLEGE OF SCIENCE (RMCS)
SHRIVENHAM**

DEPARTMENT OF MATHEMATICS AND BALLISTICS

HIGHER RESEARCH SCIENTIST

Applications are invited for the post of Higher Research Scientist to work on a project concerned with the computer modelling of the propagation of vibrations through structures. Experience in the field of applied mechanics and dynamics is required together with a knowledge of FORTRAN. The work includes the formulation and numerical solution of differential equations and an understanding of the practical engineering implications of the models being developed is necessary.

The successful applicant is likely to have a good honours degree in mechanical engineering or perhaps applied mathematics or physics. He/she will work in the Department of Mathematics and Ballistics as a member of a two-person team, and would be expected to study features of the problem not yet modelled, and to assist in their inclusion into an existing computer model. Liaison with government research establishments is involved and opportunities exist for some travel, attendance at conferences and publication of results obtained.

The appointment would be for a period of up to three years in the grade of Higher Research Scientist (salary scale £7149-£9561, depending on qualifications and experience).

From 1 August, 1984, RMCS will become a Faculty of the Cranfield Institute of Technology.

Application forms and further information may be obtained from the Civilian Administration Office, Royal Military College of Science, Shrivenham, Swindon, Wilts SN6 8LA. Tel (0793) 782551, Ext 421. Please quote reference HQ120/1/57. Closing date for applications 2 March, 1984.

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Sheffield Health Authority

MEDICAL LABORATORY SCIENTIFIC OFFICER

to be based in the Department of Haematology at the Royal Hallamshire Hospital. Candidates must be qualified to HNC level preferably in Haematology. This research post in tenable for one year commencing as soon as possible. The successful applicant will be involved in a study of the effects of fish-oils on red cell deformability.

Salary Scale: £5491, £5696, £6144, £6263, £6436, £6626, £6851, £7098, £7306, £7510, £7747.

For further information contact Dr F. E. Preston/Dr M. Greaves, Telephone Sheffield (0742) 26484, extension 2122. Application forms are available from the Personnel Department, Westbrook House, Sharrow Vale Road, Sheffield S11 8EU, Telephone 686911, extension 145. Completed application forms should be returned no later than 23 February, 1984.

I R I

**INVERESK
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INTERNATIONAL**

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Inveresk Research International Limited, a major contract research company, now requires an assistant for its Regulatory Affairs Manager to join an expanding Regulatory Affairs Unit, which provides consultancy and advise to clients on worldwide regulatory requirements and prepares dossiers for product registration and notification. The unit also publishes the Inveresk Research International Regulatory Affairs Bulletin, an executive guide to regulatory matters.

Applicants should be graduates in Pharmacy of a Life Science, working in the pharmaceutical industry, and should have some experience of work in the regulatory field, including the preparation and submission of dossiers for product registration and clinical trial clearance.

Salary for this appointment will be dependent upon qualifications and experience. In addition, the company offers modern staff benefit schemes, including free BUPA membership, and pleasant working conditions in a rural setting close to Edinburgh. Relocation assistance may also be provided, where appropriate.

Full details in writing should be forwarded, as soon as possible, to the Personnel Department, Inveresk Research International Limited, Inveresk Gate, Musselburgh, EH21 7UB, quoting reference 2605.

GRADUATE CHEMICAL ENGINEER

For 12-month Period Appointment at

**Tropical Development & Research Institute
Culham, nr Abingdon, Oxon**

The Chemical Engineering Section of TDRI is responsible for the research and development of a wide range of crop and food processing operations, especially drying. This post involves practical experimentation as well as desk studies of processing operations. The ability to apply basic chemical engineering principles to novel processing situations is essential. A working knowledge of BASIC computer techniques would be advantageous.

This post is at Scientific Officer level and normal Civil Service period-appointment conditions apply. Commencement date: mid-March 1984. SALARY: £5682 to £6313 pa depending on experience.

WRITE for application form to: Personnel Officer, TDRI, 127 Clerkenwell Road, London EC1R 5DB.

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GLC

Working for London

Waste Control Officers

Operating from area offices in Newham, Edmonton, Brentford and Carshalton, the Waste Control Group has technical responsibility for monitoring and dealing with all aspects of waste disposal throughout Greater London.

Several vacancies have now arisen at the 4 area offices for Waste Control Officers to work within multi-disciplinary teams in identifying and recording locations of waste production, handling disposal and deposit and ensuring that the relevant statutory provisions are complied with. This entails visiting industrial premises, waste transporters and disposal sites, drafting and application of disposal licences, and full involvement in investigations into contraventions of the 1974 Control of Pollution Act.

Applicants should possess a degree or equivalent in Chemistry, Environmental Pollution, Waste Control or other relevant subject *or* have extensive experience in waste control. The capacity to communicate effectively at all levels within the private and public sectors is essential as is a current driving licence. These posts are suitable for job sharing.

Salary: £8,622-£11,979 inclusive.

For an application form, to be returned by 24th February 1984, write to: Department of Public Health Engineering, Greater London Council, Room 182, North Block, The County Hall, SE1 7PB or telephone 01-633 4397.

The GLC welcomes applicants from all sections of the community, irrespective of their sex, ethnic origin, colour, sexual orientation or disability, if they have the necessary attributes to do the job.

The GLC is an equal opportunities employer

MEDICAL RESEARCH COUNCIL,
RADIOBIOLOGY UNIT, HARWELL.

TECHNICIAN OR JUNIOR TECHNICIAN

Applications are invited for the post of Technician/Junior Technician in he animal house of our Genetics Division. The work will involve the care and breeding of small mammals, including many special genetic stocks.

Minimum qualifications required are four O levels (or equivalent) including English Language and two science subjects, preferably to include Maths and Biology. Preference will be given to candidates holding IAT or TEC (Animal Technology) qualifications (or equivalent), but recent school leavers will also be considered. There are opportunities for further education.

Salary according to age and experience on the scale £3019-£4818 per annum for a Junior Technician and £5491-£7747 per annum for a Technician. There are restaurant and recreational facilities on site. Hostel accommodation may be available for single persons.

Applications, together with the names and addresses of two referees, should be sent to the Personnel Officer, MRC Radiobiology Unit, Harwell, Didcot, Oxon OX11 0RD.

Ref MFL/NH. Closing date 20 February, 1984.

DURHAM UNIVERSITY

Department of Applied Physics and Electronics

Applications are invited from candidates with good honours degrees for a

RESEARCH ASSISTANTSHIP

from as soon as possible until 31 August, 1985 to work on an SERC supported research project on novel, silicon bistable devices for integrated circuits under the direction of Dr M. J. Morant. The project includes the design, characterisation, and applications of devices structures which are fabricated in Durham and by the SERC Microelectronics Facilities.

Candidates should preferably have some postgraduate research or industrial experience of semiconductor devices. Initial salary in the range £6310-£8530 pa on Range 1B plus superannuation.

Applications (three copies) naming three referees should be sent by 24 February, 1984 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

BIOTECHNOLOGY

A vacancy exists for a Graduate Scientist in our protein biochemistry group to purify and characterize proteins produced using recombinant-DNA technology.

GRADUATE SCIENTIST
Protein Purification

Candidates should possess a degree or equivalent qualification in a relevant subject. A sound understanding and experience of modern protein separation techniques, especially chromatography, would be advantageous.

To apply, send a full c.v. quoting reference Number 194 to Jane Walley, Personnel Officer, Celltech Limited, 244 Bath Road, Slough, Berks.

CELLTECH

THE ROYAL FREE HOSPITAL
DEPARTMENT OF CHEMICAL PATHOLOGY

Graduate Biochemist

(Probationary Grade) required for nine months for evaluation of diagnostic enzyme procedures. Experience of Radio-immunoassay an advantage. Salary approximately £5900 for nine months.

For further information please contact Dr S. B. Rosalki, Department of Chemical Pathology. Tel: 01-794 0500, Ext 3488/3569.

Application form and job description available from the Personnel Department, Royal Free Hospital, Pond Street, Hampstead NW3. Tel: 01-794 0500, Ext 4286. Quote Ref LCP.

HAMPSTEAD HEALTH AUTHORITY

ASSISTANT CHEMIST
for consulting practice. Minimum qualifications HNC/HND Chemistry, with experience. School leavers, recent graduates or other disciplines will not be considered. Salary negotiable. Apply in hand written letter form with CV to: T. E. Rymer, Public Analyst, 7 Offham Road, Lewes, East Sussex BN7 2QR.

UNIVERSITY OF BATH
School of Pharmacy & Pharmacology

RESEARCH STUDENTSHIPS

Applications and enquiries are invited from candidates with first or upper second class honours degrees, or those who expect to be awarded such a degree in the Summer, for research studentships to study for a higher degree in the following general areas:

Medicinal Chemistry
Pharmaceutical Analysis
Pharmacology
Clinical Pharmacology
Pharmaceutical Technology
Pharmaceutical Microbiology
Phytochemistry

Application forms and a booklet indicating specific projects and further details may be obtained from: Professor R. T. Parfitt, Head of the School of Pharmacy & Pharmacology, University of Bath, Claverton Down, Bath, BA2 7AY

UNIVERSITY OF LEICESTER
Primary Communications Research Centre
POSTGRADUTE STUDENTSHIP IN THE COMMUNICATION OF RESEARCH INFORMATION

The Centre is concerned with research into all aspects of producing and disseminating new information. The current programme particulary emphasises studies of the impact of information technology. Opportunities exist for postgraduate students to carry out work leading to higher degrees in this area.

Applicants should have obtained at least a good Second Class Honours degree in any discipline, and have a clear interest in communication studies.

Studentships awarded for up to three years may be available for suitable candidates.

Further details and application forms are available from Professor A. J. Meadows, Primary Communications Research Centre, University of Leicester, Leicester LE1 7RH. Completed applications must reach him by 2 March, 1984.

UNIVERSITY OF BRADFORD
Postgraduate School of Pharmacy

A postgraduate

SERC/CASE STUDENTSHIP

leading to the PhD degree is available commencing October, 1984.

Project Title: Tablet lubricants—particulate and microstructural role (in collaboration with E. R. Squibb & Sons Ltd).

Applicants should possess a good honours degree in pharmacy or related subject, or expect to gain one this year, and have a particular interest in pharmaceutics or powder science.

Further details are available from: Dr P. York, School of Pharmacy, University of Bradford, West Yorkshire BD7 1DP. Tel 0274-733466, Ext 587/6126.

RSPB UWIST

University of Wales
WELSH SCHOOL OF PHARMACY

RESEARCH STUDENTSHIPS

Applications are invited for Research Studentships in the Pharmaceutical Sciences and Clinical Pharmacy tenable from 1 October, 1984. Applicants should hold, or expect to obtain, a first or upper second class honours degree.

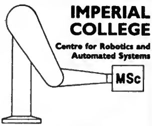
Basic Stipend at SERC rate. Maximum value of Studentship is approximately £4450, from which University fees will be paid at Home Student level.

Details and application forms are available from Professor I. W. Kellaway, Welsh School of Pharmacy, UWIST, PO Box 13, Redwood Building, Cathays Park, Cardiff CF1 3XF.

BIRMINGHAM UNIVERSITY CASE STUDENTSHIP IN SEMICONDUCTOR MATERIALS

As SERC CASE studentship is available for research leading to a Ph.D. Degree. The project, in collaboration with RSRE, involves a novel technique for the deposition of thin films and their assessment using electron-optical techniques.

For further information contact: Dr. P. S. Dobson, Dept. of Metallurgy and Materials, University of Birmingham, P.O. Box 363, Birmingham. B15 2TT.



IMPERIAL COLLEGE

Centre for Robotics and Automated Systems

IN INDUSTRIAL ROBOTICS AND MANUFACTURING AUTOMATION

An intensive conversion course starts each October for new graduates in science and technology and for those with practical experience. It leads to the MSc degree of the University of London and the Diploma of Imperial College.

The course offers a thorough grounding in production processes and in the theory, technology and **latest ideas in robotics and automated systems,** and carries this into practical work in laboratories and workshops. It tackles also the social, economic and managerial issues, crucial to the introduction of these technologies.

Close industrial links; strong practical content; opportunities to specialise.

One year full time.

Awards available: SERC, EITB, TOPS.

For details and application form, write, as soon as possible, to: The Registrar, Imperial College, London SW7 2AZ, or telephone the Centre on: 01-589 5111 Ext 2487.

LECTURES, MEETINGS AND COURSES

THE LONDON HOSPITAL MEDICAL COLLEGE

MSc Course in Experimental Oral Pathology

Applications are invited from biological science graduates with a good honours degree and an interest in oral biology, and from dental graduates, for admission to this twelve month course leading to the MSc degree of the University of London. Applicants should have at least One year of postgraduate experience. The course aims to provide a foundation of knowledge of oral disease and in particular of the methods upon which such knowledge is based, so as to serve as a starting point from which students can engage in active research, such as that leading to a PhD. Students follow a structured course of seminars and practical work for approximately six months, after which the majority of time is spent on a research project. M.R.C. training awards may be available for suitable candidates.

The course starts on 1 October, 1984. *For further information and application forms please* contact **Dr D. M. Williams, Department of Oral Pathology, The London Hospital Medical College, Turner Street, London E1 2AD (Tel. 01-247 5454 Ext 89/94).**

The closing date for applications is 9 April, 1984.

SOUTH WEST THAMES REGIONAL HEALTH AUTHORITY IN CO-OPERATION WITH THE UNIVERSITY OF SURREY

offers a training post in Medical Physics with the opportunity to study for an MSc in Medical Physics by means of a two-year block release course commencing the last two weeks in September 1984. Applicants should have or expect to obtain a good honours degree (or its eqivalent) either in physics or with physics as a principal subject by that date. During the parts of the scheme spent away from the University, the student will work in specified hospitals within the Region.

Applications are invited from suitably qualified candidates already in the Service and from graduates and prospective graduates wishing to enter the Service. Probationary physicist scale for new entrants currently £6277 or £5581 per annum depending on qualifications, increasing by annual increments, and where appropriate a London Weighting Allowance of £1042, £623 or £149 per annum. Inservice applicants may retain their current terms and conditions of service. Students will be responsible for meeting the cost of University and membership fees.

Further details and application forms available from the Academic Registrar, University of Surrey, Guildford, Surrey GU2 5XH.

Closing date for receipt of applications is 16 March, 1984. Interviews will be held on 9 May, 1984.

SOUTH WEST THAMES REGIONAL HEALTH AUTHORITY

offers two training posts with the opportunity to study for an MSc in Clinical Biochemistry at the University of Surrey, Guildford by means of a two-year sandwich course commencing 1 October, 1984. Applicants should have or expect to obtain a good honours degree (or its equivalent) in chemistry, biochemistry or other relevant biological science by that date. During the parts of the course spent away from the Unversity, students will work in a specified hospital laboratory or laboratories in the Region.

Applications are invited from suitably qualified candidates already in National Health Service employment and from those wishing to enter the Service. Probationary biochemists scale for new entrants currently £6277 or £5581 per annum depending on qualifications, rising by annual increments, and where appropriate London Weighting Allowance of £1042, £623 or £149 per annum. Inservice applicants may retain their current terms and conditions of service. Students will be responsible for meeting the cost of University and membership fees.

Further details and application forms are availabe from the Training Section, Regional Education Centre, Springfield Hospital, Glenburnie Road, London SW17 7DJ.

Closing date for applications is 16 March, 1984. Interviews will be held on 3 May, 1984.

THE BRITISH INDUSTRIAL BIOLOGICAL RESEARCH ASSOCIATION

GENETIC TOXICOLOGY COURSE

A one-week residential workshop designed to provide a broad background knowledge to genetic toxicology and its significance in general toxicology will commence on 27th February. It will be orientated towards participants with little formal knowledge of the subject and places will be limited to allow personal tuition.

The course fee is £600 + VAT for tuition, hotel accommodation and all meals.

Details from Dr K. R. Butterworth, BIBRA, Woodmansterne Road, Carshalton, Surrey SM5 4DS (01-643-4411).

RESEARCH OPPORTUNITIES IN CHEMISTRY AT THE CITY UNIVERSITY

There are vacancies in a number of the research groups in the Chemistry Department at The City University for students to pursue courses of research leading to a higher degree. The interests of the research sections of the Department are varied but include:

Industrial Chemistry
Metal recovery from waste materials, homogeneous catalysis, reactions of dispersed chemicals and adhesion science.

Inorganic Chemistry
Solid state chemistry including studies of semiconductors, X-ray crystallography.

Organic and Biological Chemistry
Chemistry of biologically active compounds (penicillins, nucleotides), photochemistry including solar energy, reaction mechanisms.

Physical Chemistry
Ion-exchange and catalysis in zeolites, combustion of gases and solids, gas phase catalysis and electrochemistry.

Many of the research projects in the Department are carried out in collaboration with industry or research associations.

Further information on these research opportunities can be obtained from Professor J. D. Donaldson, Department of Chemistry, The City University, Northampton Square, London EC1V 0HB.

KING'S COLLEGE LONDON
University of London

MSC IN HUMAN AND APPLIED PHYSIOLOGY

A one year course to train graduates in measuring and studying the physiological functioning of man in normal and abnormal environments. The course will equip students to specialise in the applications of physiology to man in industrial, Service and clinical situations and the teaching of human physiology. Topics studied include: basic measurements; life support systems; exercise; locomotor; postural; climatic; high altitude and hyperbaric physiology.

September 1984–September 1985.

Applicants should normally have a good degree in Physiology or be medically qualified.

Further details and application form from: Dr S. Rowlands, King's College London, Strand, London WC2R 2LS, quoting reference NS921.

Closing date for applications: 31 March, 1984.

KINGSTON POLYTECHNIC

GRADUATESHIP OF THE ROYAL SOCIETY OF CHEMISTRY

ONE YEAR FULL-TIME COURSE

Applicants should hold a BSc degree with chemistry as a main subject, or GRSC Part 1. The course enables candidates to gain a qualification equivalent to a good Honours degree in Chemistry. Students may be eligible for an LEA grant.

Details and application forms from Dr C. H. J. Wells, School of Chemical and Physical Sciences, Kingston Polytechnic, Penrhyn Road, Kingston upon Thames.
Tel 01-549 1366 Ext 320

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

One-day Short Course

METHODS OF SURFACE ANALYSIS

Wednesday, 7 March, 1984

A number of techniques are available to measure the composition of the outermost surface layers of solid materials. This one-day course is aimed at introducing the non-specialist in industry to the analytical information available from Auger electron spectroscopy, ESCA, SIMS and Rutherford backscattering and the ways these techniques can be used to solve problems on surfaces, thin films and surface coatings. Further details from the surface analysis laboratory. Telephone (0509) 263171, Ext 5249.

Loughborough *Leicestershire*

ACTIVITY HOLIDAYS

SNOWDONIA NATIONAL PARK STUDY CENTRE

Summer Courses

Send for our full program which includes:
Spring Flowers
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Landscape Painting
Natural History
Archaeological Excavation
Photography
Geology
Mountain Walking

Accommodation, full board and tuition in a splendid country mansion.

Send for details of the 55 courses available May to September to: Alun Davies, Plas Tan y Bwlch, PO box 1 (NS), Blaenau, Ffestiniog, Gwynned LL41 3YU. Tel: 076-685 324.

NORTH YORK MOORS NATIONAL PARK

Outstandingly delightful holiday accommodation in charming old farmhouse. Idyllic surroundings for walking, painting, bird-watching or relaxing. Excellent cuisine, comforts and atmosphere from £8·00 B & B, £6·50 E D, residential license. Brochure: Manor House Farm, Inglesby, Greenhow, Great Ayton, N Yorkshire. Tel 0642 722384.

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Fully equipped self-catering flats set in 250 acres of grounds close to the Lakes, the Dales and the coast, available July to September. FREE facilities include superb sports centre. Reduced prices for children. Colour brochure from

Shirley Lanstone, (Room 109), University of Lancaster LA1 4YW.

Tel. 0524-65201 (24 hours).

CASTEL HENLLYS PROJECT

Excavation and reconstruction of the North Pembrokeshire Iron Age Hill Fort. Volunteers required to support Archaeology – Easter, July and August. Reconstruction and May–August. Groups welcome–camping free, other accommodation available. Contact **Foster, The Coppice, Bach Road, Littlewick Green, Maidenhead, Berkshire.**

STUDY FRENCH

In a choice of host family centres or follow a language course in Tours or Paris. Also individual stays arranged for all ages to practise French and enjoy the French way of life. SAE En Famille Language Holidays, (A), Westbury House, Arundel.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

British Telecom Research Laboratories

Short-term Fellowships in 1984

Applications are invited for short-term Fellowships at the British Telecom Research Laboratories, Martlesham, near Ipswich, during 1984. The Fellowships are open to members of the academic staffs of United Kingdom Universities and are normally tenable for six weeks.

The object of the Fellowhips is to strengthen the links between the Universities and BTRL. The Fellow will be expected to carry out a short project or review study relevant to public telecommunications services and encouragement will be given to continue the work on return to University, with BT funding in suitable cases.

Apart from relevance to telecommunications in its broadest sense, no restriction is placed on the field of study and proposals of a novel and an innovative nature are particularly welcomed.

It is expected that the Fellowships will be of interest mainly to Departments of Electrical Engineering, Physics, Chemistry, Mathematics and Computer Science. However it is hoped that the academic staffs of other Departments (eg Psychology, Linguistics, Physiology) will be encouraged to apply for Fellowships with a view to initiating relevant trans-disciplinary research.

Attendance at the BT Research Laboratories will be by mutual agreement. Travelling expenses and subsistence will be paid and an honorarium (£700) will be given at the completion of the Fellowship.

Applications, including a brief curriculum vitae and a short statement indicating the proposed area of interest and its relevance to the activities of BT, should be sent to: Mr M. J. Rayner TEP6(A), British Telecom Research Laboratories, Martlesham Heath, Ipswich IP5 7RE not later than 2nd March 1984. Applications are invited from men and women.

British
TELECOM

UNIVERSITY OF SURREY

Department of Electronic and Electrical Engineering

RESEARCH FELLOWSHIP

Applications are invited for a SERC funded Fellowship to join a long established group working on ion implantation systems and applications.

The successful applicant will be required to carry out implantations and use surface analysis facilities, within the University and elsewhere, to study silicon on insulator structures, formed by the implantation of high doses of nitrogen, for applications to VLSI circuits.

Applicants should have a degree in a suitable discipline and experience in materials technology. Some knowledge of semiconductor technology, ion implantation, surface analysis techniques and device fabrication technologies would be desirable.

The appointment will be for three years at a starting salary of up to £8530 pa according to age, qualifications and experience. Superannuation under USS conditions.

Applications in the form of a curriculum vitae (three copies) including the names and addresses of two referees should be sent to the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey GU2 5XH by 24 February, 1984, quoting reference 233/NS.

LINCOLN COLLEGE, OXFORD

NUFFIELD RESEARCH FELLOWSHIP IN MEDICAL SCIENCES

The College invites applications from graduates, either men or women, for a Nuffield Research Fellowship in Medical Sciences with effect from 1 October, 1984 to 30 September, 1989. Applicants should be under 32 years of age on 1 October, 1984.

The Fellow will be required to conduct research into some science related to medicine and the College, in making the election, will give preference ceteris paribus to candidates whose proposed research is in experimental pathology or bacteriology. The Fellow will be permitted to teach up to a limit of four hours per week. The salary will be £7190, rising by annual increments to £8975 in the fifth year, together with USS. The Fellow will be given full common room rights.

Application, giving particulars of qualifications and experience and the names of three referees, should be made by 1 March, 1984 to the Rector, Lincoln College, Oxford OX1 3DR, from whom further particulars and application forms may be obtained.

WOLFSON COLLEGE, OXFORD

GUY NEWTON JUNIOR RESEARCH FELLOWSHIP IN BIOLOGY

Applications are invited from men and women, preferably under 30, for a Guy Newton Junior Research Fellowship in Biology, including Biochemistry, for three years from 1 October, 1984, at an annual stipend of £5188 plus any general percentage increase in academic salaries awarded after 1 January, 1984, together with College housing, or an allowance in lieu, and Common Table meals. The closing date for application is 28 March, 1984. Further particulars are obtainable from the Fellowships Secretary.

Atlas Research Fellowship

St. Catherine's College, Oxford University

The Rutherford Appleton Laboratory of the Science and Engineering Research Council and St. Catherine's College invite applications from engineers, mathematicians or scientists for a joint Research Fellowship. The aim of this "Atlas Fellowship" is to encourage theoretical studies, particularly those involving computation, in an area of research supported by the Rutherford Appleton Laboratory and of interest to some Fellows of the College. These areas include the following broad fields: study of condensed matter by scattering of neutron beams; computer simulation of condensed phases, especially liquids; finite element methods applied to transport processes. Candidates will be asked to present the programme of research they would propose to follow.

The holder of the Fellowship will be expected to undertake independent research work and to spend the greater part of his/her time at the Rutherford Appleton Laboratory, where exceptionally powerful computer facilities are available. He/she will also be a Research Fellow of St. Catherine's College with the full rights and privileges of a Fellow and will be associated with a relevant University Department. The Rutherford Appleton Laboratory's involvement with many University research groups provides an excellent opportunity for contacts with other research workers engaged on a wide range of research programmes. The Fellowship provides an opportunity for some teaching experience, and for close personal contact with the College in other ways.

The Fellowship will be tenable for a period of three years and may be extended for a further two years for the completion of a total period of five years. The stipend will depend upon the age and experience of the candidate selected within the broad range £9,500 to £14,800.

For details of research fellows' rights at St. Catherine's College and application forms, write to Recruitment Office Personnel Group, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX, or telephone Abingdon 0235 445435 quoting reference No: VN 202.

The closing date for applications is 2nd March 1984

serc Rutherford Appleton Laboratory

UNIVERSITY OF SURREY

Department of Physics

RESEARCH FELLOWSHIP

Applications are invited for a Research Fellowship supported by CEGB on Computer Simulation of Crystal Defects. In particular the project will consider theoretically the nucleation and early stages of growth of cavities during creep deformation. The work will involve close collaboration with experimentalists at CEGB's SE Region Scientific Services Department at Gravesend.

Candidates should have research experience in physics or materials science, preferably with a PhD and be familiar with the use of large scale computing systems.

The successful applicant will join a group headed by Professor A. G. Crocker working on crystal defects and their role in controlling the properties of materials. He or she will be expected to assist in the supervision of more junior members of the group.

The appointment is for two years and will start as soon as possible. Salary will be at an appropriate point on the IA Research and Analogous Staff scale between £7190-£11 615 pa.

Applications in the form of a curriculum vitae (three copies) including the names and addresses of two referees should be sent to the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey GU2 5XH by 2 March, 1984, quoting reference 234/NS. Further particulars are available by telephoning Guildford (0483) 571281 Ext 553.

THE ROYAL SOCIETY GOVERNMENT GRANT FOR SCIENTIFIC INVESTIGATIONS

Applications for grants from the first allotment of the Government Grant for Scientific Investigations for the year 1984 (for which the amount available will be substantially less than in recent years) should be made not later than 15 March, 1984 on forms of application to be obtained from the Executive Secretary of the Royal Society, 6 Carlton House Terrace, London SW1Y 5AG.

Applicants must be British subjects domiciled in the United Kingdom. Grants may be made to promote and support research in science and to assist scientific expeditions and collections: but not for personal maintenance, payment of stipends or to aid scientific publications. Preference is given to fieldwork at home or overseas and work at sea.

UNIVERSITY OF SURREY
Department of Physics

RESEARCH FELLOWSHIP IN THE ELECTRON MICROSCOPY OF SEMICONDUCTORS

A post-doctoral research fellowship is currently available, for 2 years, in the electron microscopy of semi-conducting materials. The project, funded by SERC, is to study the microstructure at and close to interfaces in heterostructures based on (GaIn)(AsP)/InP and to relate the microstructure to the optical and electrical properties. It is essential that the applicant has experience in the field of transmission electron microscopy or in the physics of semiconducting materials. The starting salary is up to point 9 on the RA(1A) scale (currently £10,710 p.a.) depending on experience.

For further details please contact either: Dr. P. Chersley or Dr. A. R. Adams, Department of Physics, University of Surrey. Telephone (0483) 571281.

FOR SALE

HEWLETT PACKARD desk-top computer type 9845S 64K, BYTE, CRT, Printer, Graphics, Dual Cassette, RS232. Offers invited. Contact Dr P. F. Chatterton (0256) 58222.

SERVICES

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Anything from 1000 words to book length undertaken. Rates: 80p page (Pica) £1·00 page (Elite) Tel 01-404 0700 Ext 263.

APPOINTMENTS WANTED

24 YEAR OLD MALE

BSc (Hons) in Environmental Chemistry, MSc in Pollution Control, particular interest in water pollution, seeks interesting position anywhere in UK. Box D785.

PhD, MED. CHEM.

Fifteen years Research experience, neo. jaundice, clinical, alk. recovery, publications, invention award winner, patent. Available for Post-doctoral Research. Box D784.

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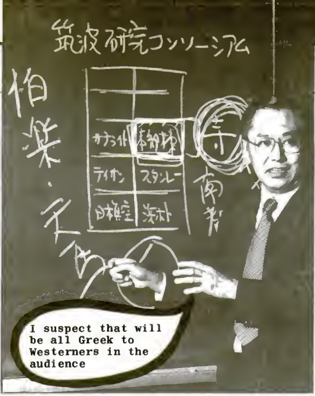

筑波研究コンソーシアム
I suspect that will be all Greek to Westerners in the audience

POSSIBLY the electronics engineers team at the University of Surrey are relaxing after building the university's second satellite in what must be record-breaking time. More likely they are biting their nails, for the spacecraft has been designed and constructed in five months, not the sort of time that anyone would normally dream of taking for so complex and fastidious a job. But the satellite is, at the time of writing, as the saying goes, finished and being thermally tested, as another saying goes, at the Rutherford-Appleton Laboratory.

Plans are to ship the satellite out this week to NASA's Western Test Range at Vandenberg in California for launch into a polar orbit on 1 March. After that, everyone on the team should be able to breathe more easily before telling the Guinness Book of Records. The satellite's progress has been matched by some hectic news releases from the university, along "every minute counts" lines, no doubt justified. Five months from start to finish, including providing two of the experiments on board, is a remarkable performance. ☐

EACH time I make this point I get letters attacking me for being, among other things, superior, pedantic, snobbish and that worst of all charges from the trendy, irrelevant. But I have at least one reader on my side, so I am sticking my head over the parapet again.

I have been sent a brochure from a firm making control equipment. Once more, I must emphasise that I am making no comment on the quality of the material that the brochure describes, which is software. It may be, for all I know, the most distinguished software ever produced. The reaction of the reader who sent me the brochure, in outrage, was that he, as a potential customer, would never buy it. The reason—the brochure is illiterate. Ironically, my correspondent writes, "I would not dream of buying their products because their software may be as error-free as their brochure".

It contains, for example, "peek overload", "the axis of the resultant curvey", and "miniture". It recommends, "The unit should be turned off when not in use to conserve battery drain." It says, "The two axis being entered when prompted for by the define axis requests determining the axis of the resultant curve." All is not lost though. "Further software can be added to enable deeper analysis of the data."

All this is amusing, for a moment or two. Unfortunately, it is, on reflection, depressing. If you cannot handle your native language with some fluency and do it the honour of spelling its words correctly, customers and more particularly foreign customers will be deeply unimpressed.

Some time ago I had a letter from a highly placed manager in the Post Office. It was full of misspellings. I wrote a mild reply pointing this out and got an angry second letter saying that it did not matter as I knew what he meant. That may be true of communications between people, though deplorable. I doubt if it is true of communications between computers. ☐

EVERY now and then we get a piece of news about Sir Clive Sinclair's new laboratory, at present being organised at Cambridge. Last June, advertisements appeared asking potential members of it to apply and now 10 people have been chosen from 1300 to join the place, called Metalab, from "meta", a Greek word meaning "beyond".

In other words, Sinclair is setting up an élite. Cor blimey, I thought that will upset all those characters going around under banners and delusions, shouting "Elitist!", if anyone as much as claims that we do not all have the same aptitudes in the same quantity. But as far as I know, not a single demonstrator has appeared on Metalab's doorstep.

Any word with "ist" added as a suffix can be used to abuse. "Leftist!" I bawl. It is not political. I am against the left-handed, an élite if ever there was one, with their talk of crossed-laterals and their arrogance. ☐

MORE about bombing the land with tree plants. I learn that the idea has been tried in at least one place, British Columbia, though the Forestry Commission at Alice Holt Lodge tell me that they have no information about how successful the scheme was.

It arose from another idea which struck a member of the Forestry Faculty of the University of British Columbia, and that was to make a planting gun to insert tree plants into the soil in containers. The trees were sown and reared in hard plastic shells rather like those for a 20 mm gun. As the plants were fired into the ground, the shell was scored so that the roots could push out.

This idea was successful, but it still meant that each plant had to be fired in by people walking slowly across a site, an exhausting job. The idea of bombing was to cut out this fatigue, and as long ago as 1970 a plane was loaded up with the planting shells and flown on its bombing runs. Either the aerodynamics of the containers were at fault or the aircraft flew too low, or both, for the shells finished at what the Forestry Commission calls "crazy" angles. Rocks and stumps were a handicap, too.

On the other hand, tree plants will grow the right way however they are placed in the ground, being negatively geotropic, so, says the Forestry Commission's Director of Research and Development, A. J. Grayson, "no doubt a fair number are growing quite happily".

It seems that the idea of bombing trees into the ground is not entirely impractical and might work reasonably well after some research on materials aircraft manoeuvres. ☐

WHEN a gas molecule hits the wall of its container, it is briefly held in a weak chemical union, and then re-emitted at some random angle. Daedalus recalls that many chemical reactions release their product-molecules in exact directions. So DREADCO chemists are devising special surface coatings, based on the fashionable Langmuir-Blodgett molecularly oriented films, which will release adsorbed gas molecules not in the usual uncontrolled way, but exactly perpendicular to their surface.

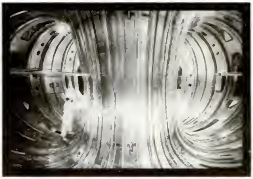
These "Stereochemically Controlled Desorption" (SCOD) surfaces will have many uses. Imagine, says Daedalus, a hollow gas-filled cylinder with planar SCOD ends. Each molecule hitting the ends will be briefly held, and then released precisely towards the other end. In time, every molecule would hit an end-face and be aligned. The result would be an "oriented gas", with all the molecules flying neatly back and forth between the ends, and transmitting gas-pressure to them alone. The circumference of the cylinder would feel no pressure, and would merely have to keep the air out.

SCOD-ended cylinders, able to transmit pure end-pressure with the minimum of weight, will revolutionise architecture. A SCOD column containing oriented gas at thousands of atmospheres end-pressure, and supporting thousands of tons, would still require only the flimsiest container. Still more cunning is Daedalus's SCOD balloon. A perfect sphere, it has a smaller sphere at its centre, with both facing surfaces SCOD-treated. As before, the air inside is soon oriented, with all molecules flying radially between inner and outer surfaces. With all molecular momentum now directed outwards, the internal air will exert one atmosphere of pressure (to balance the air outside) at only a third of atmospheric density. The balloon-skin will feel no stress, and can be as thin as desired, but its oriented-air contents will have a permanent lift of about two-thirds of that of hydrogen. Even small leaks will not matter; entering air will soon be oriented like the rest. ☐

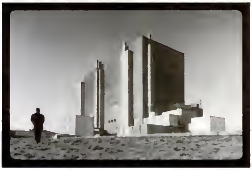
FISSION AND FUSION

FOUR NEW FILMS ABOUT ATOMIC ENERGY

All Around Us: Radiation
(25 minutes)
This film explains radiation, how it was discovered, what it is and how it is measured. Its applications and possible effects on health are considered. The film shows how radiation is used to our benefit in industry, medicine and research.



Nuclear Fusion: Energy for the 21st Century
(25 minutes)
Since 1978, Culham Laboratory in Oxfordshire has been the centre for a joint European nuclear fusion research project. This film traces the development of fusion research that has led to the construction of the Joint European Torus.



The Energy Problem – The Nuclear Solution
(15 minutes)
This film examines the world's energy situation, including the renewable sources of energy, solar, wind and wave power and our existing resources of coal, oil and gas, and explains the contribution nuclear energy can make now and in the future.

I Work in Atomic Energy
(21 minutes)
This film portrays the differing skills and outside interests of four UKAEA personnel. In this way the film presents a picture of the corporate endeavour and individual enterprise within the Authority.

OTHER SERVICES

Publications Booklets, leaflets, reprints of ATOM articles and other literature on nuclear and related subjects are provided on request.

Speakers service To help public understanding of nuclear technology and the issues involved, the Authority provide a free talks service. Speakers, usually scientists and engineers from Authority establishments, often illustrate their talks with audio-visual programmes.

Teaching pack A nuclear energy teaching resources pack compiled by Bath University is available. It includes booklets, wallcharts, filmstrips and other materials for class teaching. Details are available on request.

Mobile exhibition Authority establishments have available on free loan a small (12 light-weight panels) mobile exhibition on nuclear energy. The exhibition is easily erected and dismantled and is suitable for schools, public libraries etc.

■ All titles are available in 16mm film or video formats on free loan, or sale at £11.75 exclusive of VAT. These charges are subject to change without notice. Prices for titles on systems other than VHS and Betamax will be quoted individually. ■ All films and video tapes can be obtained from Film Library, Viscom Ltd., Park Hall Road Trading Estate, London SE21 8EL. Tel: (01) 761 3035.

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DISCUSSIONS 1984

Dinosaurs—the masters of planet Earth

Dr Beverly Halstead

6.0 pm Sunday 11 March

FOR 140 million years the dinosaurs dominated life on Earth—they rank as the most successful vertebrates of all time.

Many popular films showing dinosaurs engaged in bloody battles are based on undisciplined imagination; however, it is possible to reconstruct the life of dinosaurs from scientific evidence—how they moved, how they fed, how they brought up their young, even their social organisation, all have been worked out from the clues they left behind. The manner of their disappearance remains a subject of heated controversy among many scientists.

Dr Beverley Halstead is reader in geology and zoology at the University of Reading and a research fellow at the Royal Dental Hospital, London. He has worked at the Natural History Museum in London, and at Oxford University. He was formerly professor of geology at Panjab University, Chandigarh, India. He has published many books, including *The Evolution of the Mammals.*

Dr Halstead is an expert on dinosaurs and says that the real excitement in his work is searching for fossils and "finding something that no other human being has ever seen before." His work has taken him to Central Poland, the USSR, China and many parts of Africa, including the Sahara Desert. On one Nigerian expedition, he and his party were arrested: they spent Christmas Day in detention and had only corned-beef sandwiches for their Xmas dinner!

How we conquered the Universe and similar mistakes

Professor Jack Meadows

6.0 pm Sunday 18 March

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WHAT happened in the history of science? You hear some colourful stories—for example, an apple falling on the head of Isaac Newton—but did it really happen? Anyway, who cares? Then again, scientists sometimes make mistakes. Is it best to hide these peccadillos beneath the carpet and forget about them?

Professor Meadows sets out to explore these sorts of questions, and hopes in so doing to show that tall stories and curious mistakes are an important part of science.

Professor Jack Meadows studied Russian at the University of Cambridge; physics and astronomy at the University of Oxford; and history and philosophy of science at the University of London. He has held university posts in the US, Scotland and England. He is currently head of the Departments of Astronomy and History of Science and of the Primary Communications Research Centre at the University of Leicester. He has written various books on astronomy, history of science and communications, and an excessive number of papers on these and other topics.

How life evolved with some help from Gaia

Professor James Lovelock

6.0 pm Sunday 25 March

COMPARED with our planetary neighbours, Mars and Venus, the Earth is a strange and beautiful anomaly. How did it come to be so different?

We are usually taught that we are very fortunate to have evolved on a planet that was by chance just right for life, or, for those rare times and places when it was not, life has been able to adapt. Professor Lovelock presents a radical alternative; that the Earth is a pleasant and fit place for life because life has made and kept it so. This alternative view is the Gaia hypothesis, so named after the Greek goddess of the Earth.

To illustrate this notion, Professor Lovelock traces the development of the planet and the evolution of life from its origins until today. What are the arguments for and against Gaia? How is pollution damaging the environment of a living Earth? What insight does the Gaia hypothesis offer that might help us to solve the contemporary problems of the environment? Can it tell us how to live with, as well as on, the Earth?

Professor James Lovelock graduated in chemistry at the University of Manchester, and subsequently gained degrees in medicine and biophysics at the University of London. For 20 years, he worked with the Medical Research Council at the National Institute for Medical Research, and at the Common Cold Research Unit. He has worked in the medical schools at Harvard and Yale Universities, and at Baylor University College, in Houston, Texas, where he was a professor of chemistry. Since 1964 he has conducted independent research and has been a visiting professor, at Houston and Reading Universities.

Professor Lovelock is the author of various books, including *Gaia and the Great Extinction,* and many research papers. He has also patented about 30 inventions, mostly detectors for use in chemical analysis. One of these, the electron capture detector, first revealed the presence of pesticide residues throughout the natural environment. Some of his inventions have been adopted by NASA in its programme of exploring other planets.

MERMAID THEATRE

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